



## ANSYS RELEASE 12

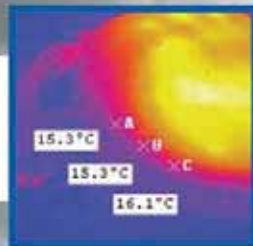
Smart Engineering Simulation is here



1-2 OCTOBER  
BERGAMO -IT

**ENGINSOFT INTERNATIONAL  
CONFERENCE 2009**  
CAE Technologies for Industry  
and ANSYS Italian Conference 2009

Modelling of condensate formation and disposal inside an automotive headlamp



Aerodynamic optimization of the Volvo Polestar Olsbergs Green Racing C30



# ENGINSOFT INTERNATIONAL CONFERENCE 2009

CAE Technologies for Industry  
and ANSYS Italian Conference 2009

1-2 OCTOBER  
BERGAMO-IT

Simulation and Virtual Prototyping are seen as key disciplines for achieving progress in engineering and science in the 21st century. In this light, EnginSoft is hosting its International Conference 2009 CAE Technologies for Industry on 1-2 October in Bergamo, Northern Italy - concurrently with the ANSYS Italian Conference 2009.

This occasion has become one of the leading events in Europe for all those involved in CAE, with record attendances in recent years.

**1st-2nd October 2009**  
**Bergamo - Centro Congressi Giovanni XXIII**

Our 2009 edition will present the diversity and impact of CAE Technologies to an international audience of users from various industries with different backgrounds, developers, scientists and researchers. The two Conferences will offer a highly innovative platform for interaction and exchange of knowledge, development and application results. Moreover, they will reveal convincing visions for the future of engineering simulation in industry, research and the academia.

The program will feature presentations from leading experts and key companies from around the world highlighting applications in automotive, aerospace, energy, marine, oil&gas, consumer goods, environment, biomedicine and other areas.

In several product update sessions, conference attendees will hear about the latest developments of state-of-the-art CAE software encompassing:

ANSYS - ANSYS CFX - ANSYS Fluent - ANSYS ICEM CFD - modeFRONTIER - ANSOFT - Flowmaster - MAGMASOFT - FORGE - FTI - THIRD WAVE SYSTEM - LS-DYNA - ESACOMP

A Demo Room will be available throughout the conference where attendees will meet for interactive discussions and live demos of the latest software releases.

The official language of the EnginSoft International Conference will be English.

To complete the information flow during the two conference days, a large accompanying exhibition will see the world's leading solution providers showcasing products and services covering all aspects of CAE technologies and their successful implementation.

As a tradition, delegates and exhibitors will use the exhibition as an international networking forum to gain new insights, share experiences and to find new business opportunities.

Follow the Sound of Innovation - Be Inspired about CAE - Come and meet us in Bergamo!

[www.caeconference.com](http://www.caeconference.com)

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EARLY BIRD REGISTRATION UNTIL 31 JUNE 2009

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# ENGINSOFT INTERNATIONAL CONFERENCE 2009

CAE Technologies for Industry  
and ANSYS Italian Conference 2009

1-2 OCTOBER  
BERGAMO-IT

La simulazione al computer e la prototipazione virtuale sono considerate tra le discipline chiave per progredire nell'ambito dell'ingegneria e della scienza nel XXI secolo. In questa prospettiva, EnginSoft propone la sua Conferenza Internazionale 2009 sulle "Tecnologie CAE per l'industria" nei giorni 1 e 2 ottobre a Bergamo, in concomitanza con la conferenza italiana ANSYS 2009.

La manifestazione organizzata annualmente da EnginSoft è divenuta uno degli eventi di maggiore rilevanza in Europa per quanti hanno a che fare con il CAE: lo dimostra, anche la partecipazione record registrata negli ultimi anni.

**1st-2nd Ottobre 2009**  
**Bergamo - Centro Congressi Giovanni XXIII**

L'edizione 2009 fornirà aggiornamenti sulle diverse tecnologie per il CAE, e sul loro impatto ad un pubblico internazionale di utilizzatori provenienti da diversi comparti industriali e da diversi contesti della scienza, della ricerca, e dello sviluppo del software. La conferenza costituirà una "piattaforma" altamente innovativa per l'interazione e lo scambio di conoscenze, sia in merito alle tecnologie, che alla loro applicazione, sia per quanto riguarda l'attuale stato dell'arte, che le prospettive di sviluppo.

Il programma si articolerà in presentazioni di illustri esperti e aziende leader a livello mondiale che evidenzieranno applicazioni in ambiti: automotive, aerospace, energia, navale, oil&gas, beni di consumo, biomedicina ed altri ancora.

Nelle diverse sessioni di aggiornamento sui prodotti software verranno illustrate le novità, e le linee di sviluppo future degli applicativi software sostenuti da EnginSoft: ANSYS – ANSYS CFX – ANSYS Fluent – ANSYS ICEM CFD - modeFRONTIER – ANSOFT – Flowmaster – MAGMASOFT – FORGE – FTI – THID WAVE SYSTEM – LS-DYNA – ESACOMP.

Per una maggior dinamica nello scambio delle informazioni, i partecipanti potranno visitare una "demo room" permanente, in cui, a rotazione, verranno ripetute presentazioni dal vivo delle nuove, maggiori funzionalità dei software. Completa, come d'uso, la manifestazione, un ampio spazio espositivo in cui sarà possibile incontrare i fornitori software e hardware delle migliori soluzioni a livello mondiale, e ricevere da loro informazioni sui prodotti e sui servizi offerti. Relatori, partecipanti, ed espositori potranno usufruire anche di questa opportunità per allargare la manifestazione ad effettivo forum internazionale, in cui "fare rete", aprirsi a nuove prospettive, condividere esperienze e trovare nuove opportunità.

Follow the sound of innovation, get inspired about CAE.

Vieni a trovarci a Bergamo!

Sito dell'evento: [www.caeconference.com](http://www.caeconference.com)

Per maggiori informazioni:  
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# CAE Conference 2009 Provisional Paper List

## FEM

<b>Ansaldo Energia</b>	FEM approach to turbogenerator design
<b>CADFEM</b>	Explicit Solutions in ANSYS Workbench and their Applications
<b>CADFEM</b>	Composites and their numerical Simulation
<b>Continental</b>	Design to Cost and Magnetic Optimization for a Gasoline Injector
<b>Dynamore</b>	Car crash simulations and occupant safety with LS-DYNA
<b>Dublin University Ireland</b>	Finite element simulation of bulge forming of multi-layered tubular components using a solid pressurizing medium
<b>Indesit</b>	Analisi di sensitività alla posizione dei vincoli su un vetro da forno pirolitico
<b>INFN</b>	R&D on carbon fiber systems for evaporative cooling of detector components
<b>INTEC GmbH Germany</b>	Modeling and simulation of contact mechanics with SIMPACK multi-body simulation software
<b>Koacaeli University Turkey</b>	Effects of fibula and talus on the stress distribution of tibia bone
<b>Magneti Marelli</b>	Welding Lines stiffness in Loaded Plastics Components @ Burst Conditions
<b>MTA</b>	Modellazione numerica di contatti termoelettrici
<b>Piaggio</b>	CAE analysis of an intake valve for bike application
<b>Proship</b>	Analisi strutturali su porzione di nave con analisi di dettaglio su particolari complessi
<b>Saipem</b>	Analisi di impatto d'ancora su tubazione sottomarina

## CFD

<b>Angelantoni</b>	Development of A Simplified Model for the Simulation of a Climatic Chamber – Part1: Steady Case
<b>Ansaldo Caldaie</b>	Analisi Fluidodinamica dei condotti di alimentazione aria di un generatore di vapore
<b>Automotive Lighting</b>	Modelling of condensate formation and disposal inside an automotive headlamp
<b>AVIO</b>	CFD aerodynamic and reactive study of the innovative PERM injection system for the AVIO combustor in the frame of the NEWAC Project
<b>CSM Tenova</b>	CFD Simulation of combustion systems for steel reheating furnaces
<b>Barbalab and C.S.T.</b>	Multi-phase CFD study of a reciprocating gas compressor with liquid slag ingestion
<b>Casale Group</b>	The use of Fluent in the fluid dynamic design of ammonia and methanol plants
<b>Danieli</b>	Analisi CFD di una paniera per colata industriale
<b>ENERGO</b>	Using ANSYS Flowizard for performance evaluation of air distribution elements
<b>ENI</b>	Sviluppo di un separatore gas/liquido sonico mediante Fluent
<b>Koacaeli University Turkey</b>	Design and Flow Simulation of An Open-Circuit wind Tunnel
<b>Nuovo Pignone</b>	Ejectors on compressible network for Gas Turbine extended operability
<b>Saipem</b>	CFD Modelling of Air-Cooled Heat Exchange Performance in an LNG Plant
<b>Tetrapak</b>	Simulation of the interaction between packaging material and air/liquid flows during the sterilization process of food containers
<b>Franco Tosi Meccanica</b>	Transient CFD analysis of a full pelton turbine
<b>RBF Morph</b>	RBF Morph: a fast meshless morpher for Fluent

## OPTIMIZATION - PIDO

<b>ABB Switzerland</b>	Stochastic optimization for industrial applications
<b>A-Dev - Sweden</b>	Multi-objective optimization of an automotive aluminium part
<b>Aprilia Racing</b>	Aprilia Racing: a recent modeFRONTIER application on high performance motorbikes, using co-simulation techniques
<b>Casappa</b>	Optimization of the thrust plate geometry in external gear pumps
<b>Cranfield University - UK</b>	An integrated Framework for MEMS design optimisation using modeFRONTIER
<b>Czech Technical University</b>	Optimization of 2-Stage Turbocharged Large-Bore SI Engine using modeFRONTIER
<b>Debrecen University - Hungary</b>	Automatic multi-objective surface design optimisation using CAD/CAE integrated system of modeFRONTIER: Application to military submarine sail design
<b>Ecole Centrale de Lille -France</b>	Optimam Design of a Safety Isolating Transformer with modeFRONTIER
<b>Force India F1</b>	modeFRONTIER use for Vehicle Dynamics at Force India F1
<b>GRC - UK</b>	Design space exploration in ship concept desing using Paramarine and modeFRONTIER
<b>Grontmij</b>	Advanced Techniques for Verification of Hydraulic Sewer Models
<b>Jaguar</b>	Success and challenges of the Jaguar LandRover MDO with modeFRONTIER
<b>Linköping University -Sweden</b>	Design Automation Framework for Micro Air Vehicles
<b>Piaggio &amp; C.</b>	Analysis of a scooter muffler internal geometry for the optimization of tailpipe noise sound-quality at idle condition using modeFRONTIER coupled with 1D wave build 3D simulations
<b>Piaggio Aero</b>	Design and Numerical Optimization of Winglets and assessment of optimization algorithms
<b>Pole European Plasturgie -France</b>	Multi-objective optimization applied to the mass reduction of a plastic part
<b>modeFRONTIER Racing</b>	modeFRONTIER DOE Techniques for Racing Car Design
<b>Sulzer Pumps</b>	Multi Variate Analysis in Systematic Impeller Design Applying modeFRONTIER
<b>Tekniker - Spain</b>	Integration of Experimental Data in a Two-Stroke Engine Cylinder Modelling
<b>Thales Alenia Space</b>	Optimization of complex performance for spacecraft antennas
<b>University Freiberg -Germany</b>	Advanced Coupling of modeFRONTIER and Aspen Plus in Energy Process Engineering



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## Newsletter EnginSoft Year 6 n°2 - Summer 2009

Per ricevere gratuitamente una copia delle prossime Newsletter EnginSoft, si prega di contattare il nostro ufficio marketing: [newsletter@enginsoft.it](mailto:newsletter@enginsoft.it)

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*The EnginSoft NEWSLETTER is a quarterly magazine published by EnginSoft SpA*

Applicazioni sempre più esigenti  
richiedono elaborazioni  
sempre più veloci.



L'utilizzo di modelli CAE sempre più complessi nelle quotidiane applicazioni dell'ingegneria necessita di infrastrutture computazionali efficienti, affidabili ed a basso costo.

E4 Computer Engineering si propone come una realtà italiana di eccellenza nell'integrazione di soluzioni dedicate al calcolo ad alte prestazioni (HPC); l'offerta di E4 si basa su un'estesa gamma di prodotti: workstation grafiche, server, storage, SAN, fino ai sistemi cluster "chiavi in mano" di grandi dimensioni, tutti progettati in base alle esigenze del cliente e testati secondo rigorose procedure per offrire soluzioni scalabili ed affidabili nel tempo garantendo il ritorno degli investimenti sull'hardware.

*The usage of ever more complex CAE models within daily engineering applications calls for computing infrastructures which are together, efficient, reliable and low cost.*

*E4 Computer Engineering excels at integrating solutions for the High Performance Computing (HPC); E4's range include a broad selection of products: from computer graphics Workstations, to server, storage, SAN, up to powerful custom built cluster systems, each one of them designed following the client's requirements and tested according to strict procedures, in order to provide scalable solutions which are reliable even as time goes by and guarantee a profitable return on hardware investments.*

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# EnginSoft Flash



**Ing. Stefano Odorizzi**  
General Manager EnginSoft

Summertime always sees the EnginSoft teams committed to the planning of our annual International Conference which carries the motto: CAE Technologies for Industry.

We are delighted to announce that the Program of 1st & 2nd October could already include an incredible number of presentations which we received in response to our Call for

Papers. This is exceptionally positive feedback from the simulation community despite difficult times, reduced travel budgets and other constraints. The 2009 Program will feature contributions from speakers from around the world reflecting the diversity and impact of CAE Technologies. The EnginSoft International Conference and ANSYS Italian Conference 2009 will offer a highly innovative platform for interaction and exchange of CAE and VP knowledge, development and application results. Moreover, they will reveal convincing visions for the future of engineering simulation in industry, research and the academia. We are proud to welcome Microsoft and E4 Computer Engineering as the first Gold Sponsors and NAFEMS International as the official Patron of the 2009 Conferences in Bergamo.

Among the software which will be presented, also in the large accompanying exhibition, are:

ANSYS - ANSYS CFX - ANSYS Fluent - ANSYS ICEM CFD - modeFRONTIER - ANSOFT - Flowmaster - MAGMASOFT - FORGE - FTI - THIRD WAVE SYSTEM - LS-DYNA - ESACOMP...

This edition of the Newsletter informs our readers about European Saloon Car Racing "Made in Sweden" with the C30 Volvo Racing Car running on 100% E85 Bio-Ethanol and Aerodynamic optimization performed with modeFRONTIER. Basics of the technology are reflected in the articles on "Handwritten pattern recognition with modeFRONTIER" and

the effective use of the program for Statistical Applications and such interesting questions as, "what is the highest, lowest or richest city in Italy?"

With the support of Automotive Lighting Italy, we could create a thorough article on "Modeling of condensate formation and disposal inside an automotive headlamp" which addresses an important but rarely covered topic in the automotive engineering field.

News from the modeFRONTIER network come from APERIO Spain and two successful Seminars on Product Process Integration held in the Barcelona and Bilbao regions.

EnginSoft GmbH reports a growing demand for multi-objective optimization in Germany and Switzerland and sees clear benefits for R&D.

EnginSoft France showcased its flagship products modeFRONTIER™ V4.1 and Flowmaster™ V7, to the aerospace industries at this year's International Paris Air Show.

As always, we include a detailed Event Calendar for our readers with information on where EnginSoft can be met in Europe at the various events we are attending or hosting.

Last but not least, an absolute premiere: The Japan Column - which will, from now on, bring to our readers exceptional insights into the Japanese "CAE Culture" including news, events and lots of interesting facts and background knowledge. I hope you will join me in discovering more about MONODUKURI, Japanese engineering spirit and traditional manufacturing. "The Land of the Rising Sun", its people and their culture, are marvelous at delivering quality to a product and to new developments by applying technology, regardless of whether it concerns CAE or BONSAI (the art of aesthetic miniaturization of trees) and KAISEKI (a type of art that balances the taste, texture, appearance and colors of food)...

The editorial team of the Newsletter invites you to enjoy the various contributions and welcomes any comments or ideas you may have.

Please mark your diary for the 1st & 2nd October and follow our publications on the EnginSoft International Conference, [www.caeconference.com](http://www.caeconference.com), one of the largest events for CAE users in Europe.

We hope to see you in Bergamo!

Stefano Odorizzi  
Editor in chief

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# ANSYS CFD 12: la simulazione fluidodinamica in ANSYS

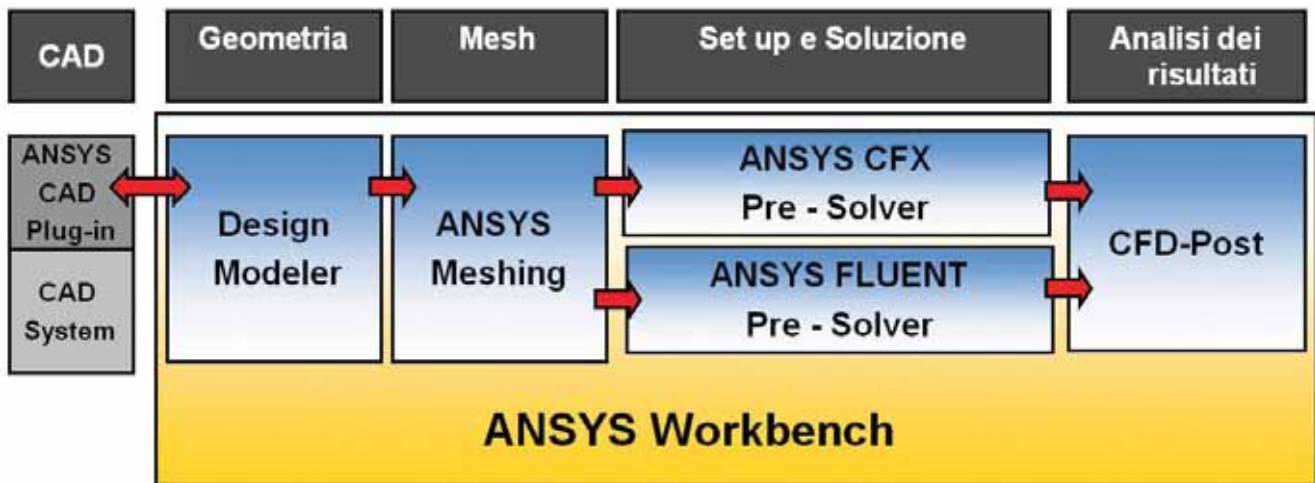


Figura 1: struttura di ANSYS CFD 12

In questo articolo viene data una visione d'insieme degli strumenti per la simulazione fluidodinamica nella nuova versione ANSYS CFD 12. Dopo l'acquisizione dei due solutori CFX e Fluent e dei relativi strumenti di meshatura avvenuta negli ultimi anni da parte di ANSYS Inc., la nuova release ANSYS 12 è il primo passo di reale integrazione dei due codici CFD e di unificazione degli strumenti di Pre e Post-processing. In questo articolo vengono descritti la struttura e i contenuti di ANSYS CFD 12 e vengono illustrati i vantaggi dell'integrazione, un processo graduale che mantiene inalterate le peculiarità dei due solutori, ma che si pone come obiettivo la creazione di un unico software CFD che fonderà le migliori caratteristiche di CFX e Fluent garantendo continuità ad entrambi i codici.

## Introduzione: struttura di ANSYS CFD 12

Nella nuova versione ANSYS 12 gli strumenti per la simulazione fluidodinamica sono stati completamente integrati nell'ambiente di lavoro ANSYS Workbench e prendono ora il nome di ANSYS CFD 12.

In figura 1 si illustra come la piattaforma Workbench comprenda sia gli strumenti di Pre-processing (geometria e mesh) e Post-processing (analisi dei risultati) sia i due solutori ANSYS CFX e ANSYS Fluent. L'obiettivo di questo approccio è quello di unificare la procedura di analisi e rendere disponibili i migliori metodi di Pre e Post-processing agli utenti di entrambi i solutori CFD, mantenendo le peculiarità dei due codici in termini di modelli fisici e numerici.

## ANSYS Workbench e gli strumenti di meshatura di ANSYS CFD 12

Nella nuova versione l'interfaccia di Workbench è stata ridisegnata e consente di definire flussi di lavoro analoghi per i due solutori CFD, i quali possono quindi condividere un unico modello geometrico, la stessa griglia di calcolo e una procedura di post-processing comune.

La definizione di un flusso di lavoro permette di gestire facilmente le diverse fasi di analisi e consente l'aggiornamento automatico di un intero progetto a seguito di una modifica al modello. Inoltre in ANSYS Workbench è possibile definire flussi di simulazione con condivisione di dati tra model-

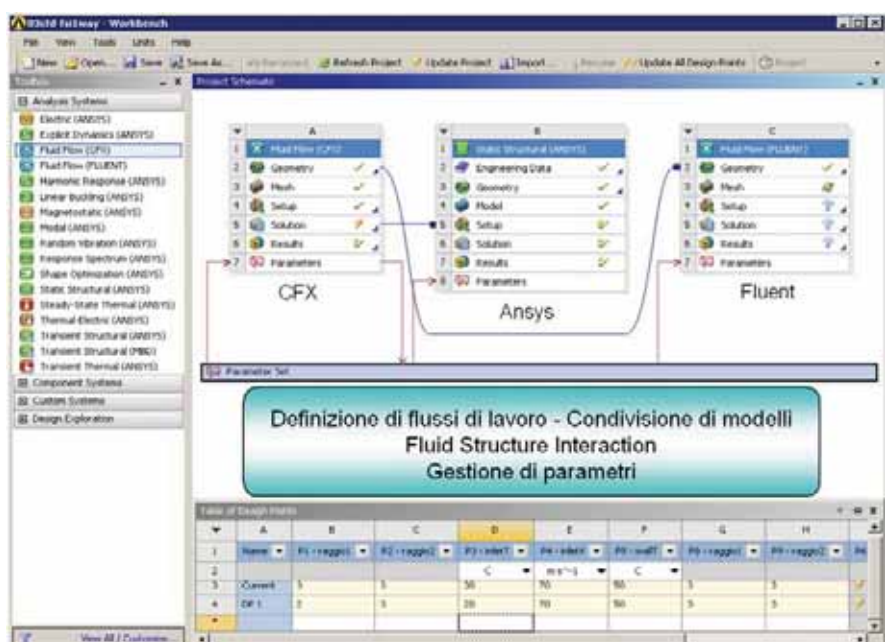


Figura 2: flussi di lavoro in ANSYS Workbench e condivisione di modelli



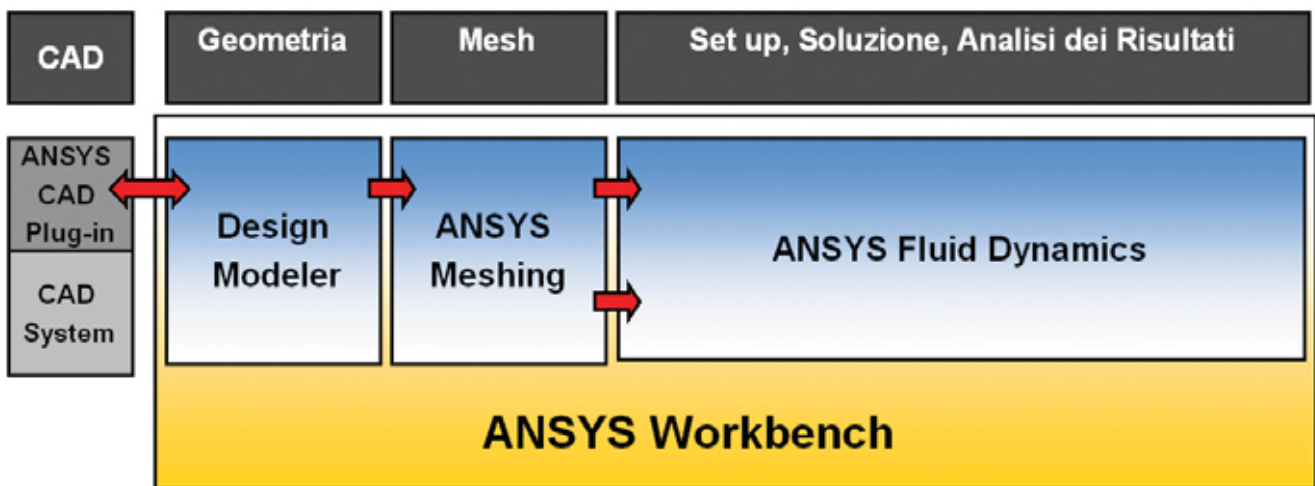


Figura 3: Il futuro di ANSYS CFD: fusione dei due solutori CFX e Fluent

li CFD e FEM per analisi di interazione fluido-struttura. Questo tipo di simulazione, già possibile nella precedente versione per ANSYS CFX, è ora disponibile anche per ANSYS Fluent.

Altro aspetto importante è la possibilità di definire parametri sia nel modello geometrico sia nel set-up delle analisi e pianificare il lancio di una sequenza di simulazioni. L'acquisizione e la gestione dei risultati per analisi parametriche avviene sempre all'interno di Workbench tramite tabelle e grafici che consentono il confronto di soluzioni alternative.

Dal punto di vista della modellazione geometrica sono state consolidate le interfacce bi-direzionali verso i più diffusi strumenti CAD. Questo consente di leggere geometrie parametriche da CAD, modificare il modello in ANSYS DesignModeler, eseguire una serie di simulazioni e restituire la geometria ottimizzata al CAD stesso.

Un ulteriore passo avanti è stato fatto nella creazione di un'unica piattaforma ANSYS Meshing che permette di generare griglie di calcolo per le diverse discipline: FEM, CFD, analisi elettromagnetiche e dinamica esplicita. I metodi e gli algoritmi di meshatura di CFX-Mesh, Gambit, ICEM-CFD e T-grid sono confluiti in questo ambiente, che propone anche nuovi metodi, come il Multi-Zone, che consente di utilizzare diversi approcci in diverse aree di uno stesso dominio di calcolo (per esempio tetra-prism su una parte del volume e Hexa-Dominant su un'altra regione).

Come detto, il processo di integrazione di diversi strumenti avviene gradualmente e garantendo continuità a software di meshatura avanzati come ICEM-CFD e T-grid, che rimangono disponibili come software stand-alone.

**ANSYS CFX e ANSYS Fluent: una linea di sviluppo comune**  
Scorrendo le novità nei due codici CFD ci si rende conto che i due solutori seguono una linea di sviluppo comune basata su alcuni punti fondamentali:

- Robustezza e accuratezza del solutore, efficienza del calcolo parallelo: sia in CFX che in Fluent sono state introdotti nuovi schemi numerici, per esempio per la soluzione del campo turbolento con schemi accurati al secondo ordine. In entrambi i codici è stata migliorata l'efficienza di partizionamento e delle operazioni di Input/Output durante il calcolo parallelo con sensibili incrementi di velocità di calcolo.
- Simulazione di motori a combustione interna: tema fondamentale in ambito CFD è stato sviluppato sotto diversi aspetti: dai modelli multifase a quelli di combustione come spiegato di seguito. Un aspetto in cui sono stati fatti notevoli passi avanti è quello della simulazione di grandi deformazioni del dominio fluidodinamico con nuove metodologie di re-meshing e di gestione di diversi set-

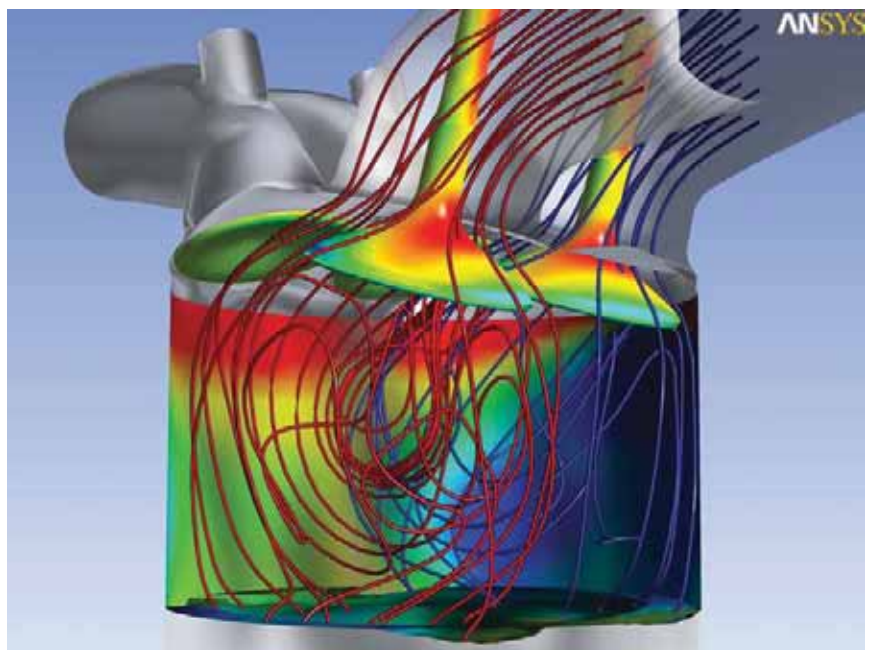


Figura 4: flussi in un motore a combustione interna



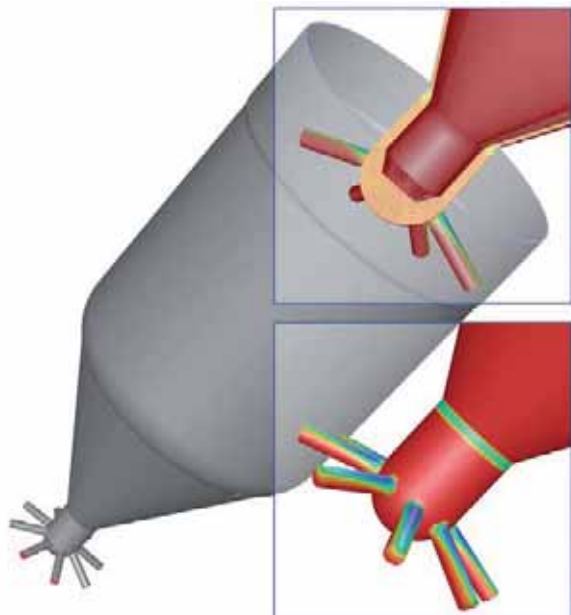


Figura 5: cavitazione in un iniettore

up di analisi all'interno di un'unica simulazione (multi-configuration).

- **Modelli multifase:** nell'ambito dei modelli Lagrangiani sono stati introdotti nuove modalità di iniezione di particelle/gocce e nuovi modelli di break-up primario e secondario. Inoltre sono stati aggiunti modelli per lo studio dell'interazione tra gocce e pareti. Nell'ambito del modello Euleriano-Euleriano sono disponibili un solutore accoppiato sulle frazioni di volume anche per flussi non omogenei, è stato introdotto un modello di wall-boiling e nuovi "Population balance Models".
- **Modelli di combustione:** sono stati introdotti nuovi modelli per la simulazione di motori a combustione interna quali Extended Coherent Flame Model, un modello di Auto-Ignizione, e modelli per tener conto dell'interazione fiamma-pareti e per il ricircolo di gas esausti.
- **Cavitazione:** in Fluent sono disponibili nuovi modelli di cavitazione, di cui uno è stato derivato da CFX
- **Scambio termico:** sono disponibili nuove modalità di simulazione con scambio termico coniugato sia attraverso solidi modellati in 2D, sia attraverso domini solidi posti in moto relativo rispetto al dominio fluido
- **Interazione fluido-struttura:** oltre alla possibilità di interazione fluido-struttura 1-way e 2-way tra ANSYS CFX e il solutore FEM è ora possibile eseguire analisi FSI 1-way con ANSYS Fluent all'interno di Workbench e sono disponibili nuove modalità di trasferimento dati anche su regioni 3D. Sono disponibili inoltre un solutore a 6 gradi di libertà integrato nel solutore CFD ed è possibile utilizzare il metodo "Immersed solids".

## ANSYS CFD 12: Conclusioni

Possiamo concludere che con la versione ANSYS 12 è stato completato il primo passo del processo di unificazione degli strumenti di simulazione fluidodinamica. Con ANSYS CFD 12 gli utenti di ANSYS CFX e ANSYS Fluent si troveranno ad usare i medesimi software di Pre e Post-processing seguendo un flusso di simulazione unico.

Rimangono divise la fase di set-up delle analisi e i due solutori, i quali continuano ad essere sviluppati separatamente, ma seguendo le stesse linee guida. I punti di forza dei due

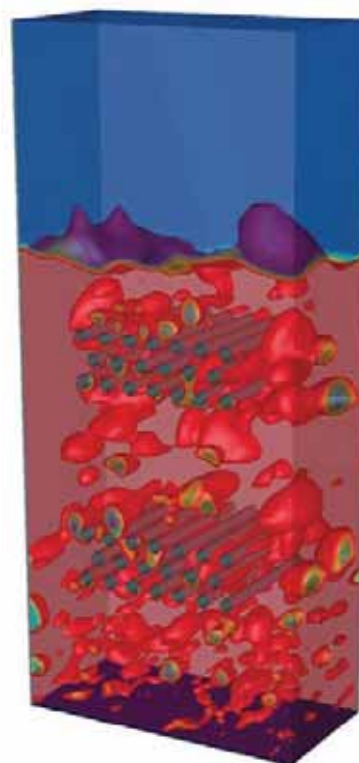


Figura 6 : flusso multi-fase

codici sono stati condivisi e una serie di modelli sono stati trasferiti da un codice all'altro secondo una logica di sinergia tra i due team di sviluppo. Volendo dare uno sguardo al futuro e utilizzando le parole del responsabile della ANSYS Fluid Business Unit, nei prossimi anni non verrà creato un nuovo codice CFD da zero, ma verrà finalizzata la fusione di ANSYS CFX e ANSYS Fluent, garantendo compatibilità con le precedenti versioni e dando visibilità agli utenti dei benefici della fusione.

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Figura 7: strutture turbolente generate durante un atterraggio



# Thermal-structural analysis of a Cylinder Head using the Workbench Platform. A unique calculation environment for different vertical codes

The design and verification of a cylinder head is usually the most critical application of the structural optimization of the assembly behavior.

Nowadays, complex geometries and different schematization requirements due to CFD and structural issues are causing an infinite number of problems. These technical difficulties are mainly related to different meshing topologies and to the single non-linearity of each numerical code.

This article describes the flexibility of the Workbench Platform, a technical approach that is characterized by its capability to connect the different codes and, at the same time, to point out the single peculiarities of each code.

A CFD analysis using the Vectis code was performed. The results with regard to convection coefficients and bulk temperatures were mapped on a FEM thermal meshing generated in the ANSYS Simulation environment. Then, these results were used for the structural non-linear analysis performed in ANSYS.

At the same time, a pilot project has been developed with the aim to verify the efficiency of the Workbench 12.0 platform as a unified environment. All the technical activities of the project were focused on a fluid dynamic, thermal-structural analysis applied to an automotive cylinder head.

The analysis has been completely performed with the ANSYS Workbench 12.0 platform. The engineers involved in the work could take advantage of the following Workbench capabilities:

- Multiphysics platform
- Tool for integration of different technologies (external fluid dynamic software, ANSYS Thermal, ANSYS Mechanical)
- Tool for advanced meshing and solving of models with a high number of degrees of freedom.

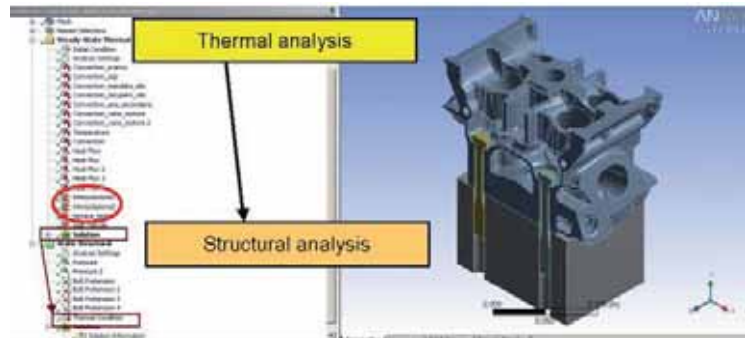


Figure 2: the simulation tree



Figure 3: the customized interface: link to the remapping macros

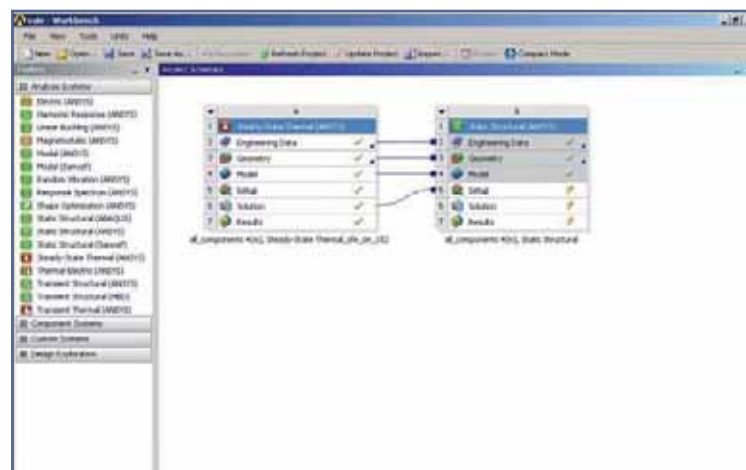


Figure 1: Logical flux – from CFD to thermal structural analysis

When we look at the details of the project work, they can be best described and summarized as follows:

The logical flux of the analysis of a cylinder head which starts with the CFD results of the combustion chamber and the cooling system obtained by the Vectis code, transfers the information from the thermal analysis to the structural pre-stressed non-linear analysis in ANSYS.

The added-value of this project is the customization of the Workbench interface which, in fact, realizes an automatic link to the Vectis results and ensures the possibility of remapping the fluid dynamic results on the thermal-structural mesh. The latter is completely different from the CFD model.



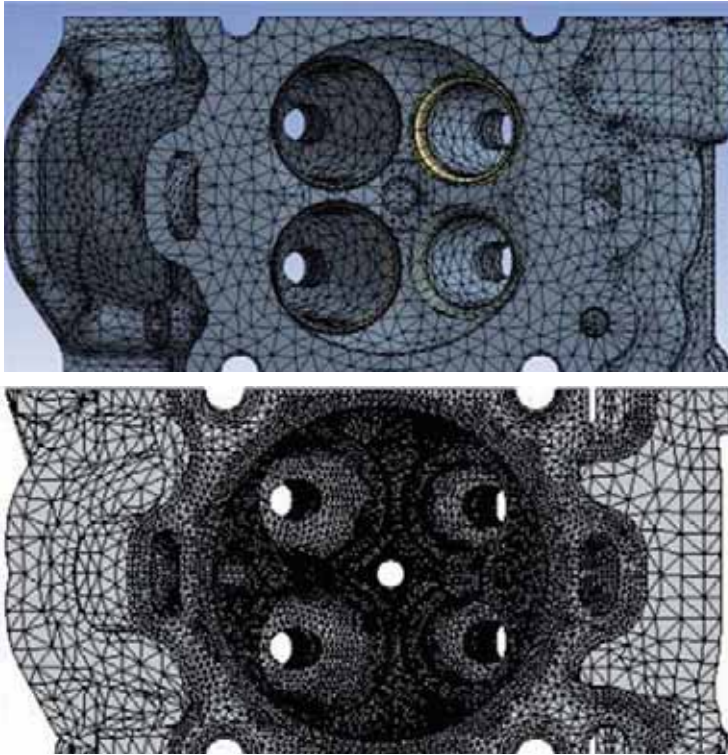


Figure 4: thermal-structural coarse mesh-CFD fine mesh

**First step: From CFD results to thermal conditions**

So far, the traditional working process has been to perform a unique mesh for the CFD and thermal-structural analysis in order to be able to remap the fluid dynamic results, in terms of bulk temperatures and convective coefficients, on the mechanical mesh. Hence, the thermal-structural model had to be created with the same topology as the CFD model which caused long modeling times.

Furthermore, the software used for the fluid dynamic, thermal and structural analysis, in many cases, belonged to different families of software (ANSYS, Nastran, Abaqus, Vectris...). This scenario caused considerable increases in costs and a number of problems concerning interfaces and other interpolations.

Owing to the newly introduced procedure, it has become possible to interpolate, in an automatic way, the fluid dynamic results on the mechanical mesh which is completely different (from a topological point of view) to the CFD grid. This led to a severe reduction of modeling time and number of obtained elements (from a fine CFD mesh to a coarse thermo-structural model). The only constraint for the proper interpolation of the CFD results is to have a proper spatial positioning of the thermal structural model compared to the fluid dynamic model. In other words, the two geometrical models must have

the same spatial position. Thanks to the new customization realized with the j-script and ANSYS APDL language, it is now possible to apply the correct fluid dynamic loads simply by taking into account the Vectris results file and by creating a component with those nodes that require the interpolation. In this way, the same model can be used to perform the thermal analysis and the structural pre-stressed analysis, saving time during the preparation and the solution of the model, thus avoiding further phases of interpolation of temperature values for the structural model.

**Second step: From thermal analysis to structural analysis**

The results of the thermal analysis, performed with bulk temperature and convective coefficient evaluated with the CFD method, are transferred to the structural model without any further interpolation thanks to the same FEM model which can be used for both analyses.

In this specific case, the analysis was carried out in several steps to take into account the pre-heat stress, and to subsequently model both: the phase of bolts clamping and the phase of the valve seat clamping with the head. The last step represents the real loading phase linked to the pressure in the combustion chamber. Both the non-linearity related to material yielding as well as the non-linearity related to contacts are considered.

This procedure is automatic and it requires limited efforts by the user. Therefore, it is very easy to perform another analysis with the same logical flux, but with different geometries or under different fluid dynamic conditions. It is also possible to utilize the model and/or the results of the structural analysis to perform a fatigue evaluation or a creep calculation.

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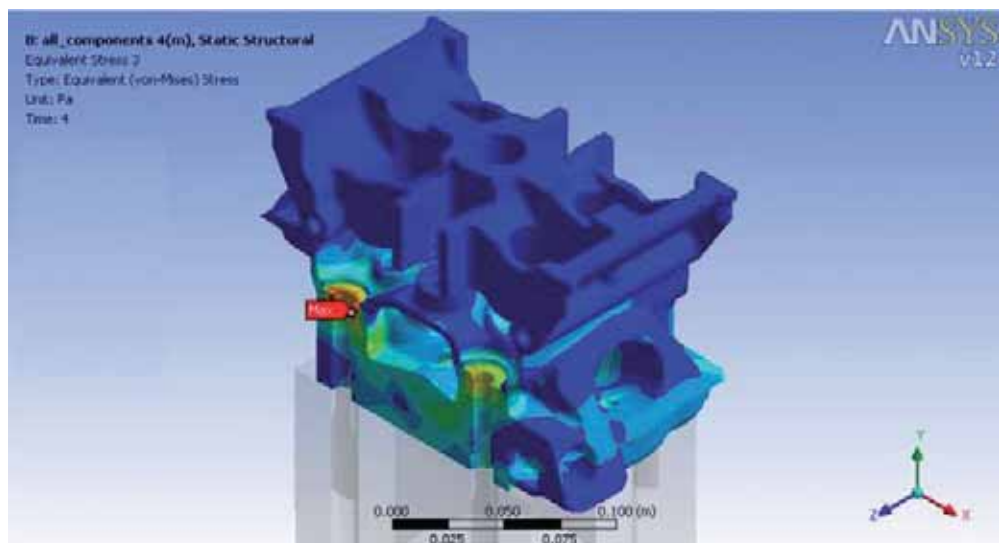


Figure 5: Equivalent Von Mises stress in the last time step



# Modeling of condensate formation and disposal inside an automotive headlamp

An automotive headlamp is an environment with high thermal and low mass exchanges with the external environment; for these reasons, humidity can accumulate inside the headlamp and can condensate on the lens. A headlamp design can be produced only if, under severe thermal conditions, all the formed condensate is disposed in a fixed time. The combined use of experimental studies



Figure 1: comparison of an old-fashioned glass headlamp (left) and a new transparent plastic headlamp (right)

and numerical modeling is an important tool to optimise headlamp design and to produce high performance headlamps.

Experimental studies are to be performed in climatic chambers under highly controlled conditions. On the other hand, long transient numerical simulations are to be performed on large meshes in order to capture the relevant physics of the problem. A new numerical method has been implemented in order to study this problem and has been applied to real case headlamp designs providing good agreement between numerical and experimental results.



Figure 2: condensate on a prototype specifically designed for enhancing condensate formation. Left: prototype mounted on the car. Right: details of the prototype

## INTRODUCTION

Automotive design has always been driven by aesthetic choices. In this context, technology plays an important role to meet the challenges linked to design solutions and the requirements of car stylists and automotive designers. Aerodynamic and curved shapes, new materials and coatings often contrast with economic and production needs.

Headlamps play a key role: located on the front of the car, lighted, with sophisticated technological solutions such as LED, light-guide and adaptive lighting systems, they have always been used by stylists to enhance aesthetics. On the other hand, mechanical and optical designers have to satisfy many functional requirements. Crash and safety tests, thermal behavior, and obviously lighting performances are only few of a great number of technical needs. The right solution for the conjugation of aesthetics and technologies involving cost and production requirements is not always easy to find and often new problems appear during project development.

Something similar happens with condensate formation and disposal. The increase of moulding capabilities leads to a massive production of large transparent plastic lenses. Until few years ago, lenses were typically designed using glass and covered by optical prism to obtain the correct light distribution (see Figure 1). Curved shapes and transparent surfaces opened a new world for style solutions, but a transparent lens lets the eye go into the headlamps (see Figure 1). Today, the observer has a free view of the inside of the headlamp highlighting even the smallest optical fault, any thermal damage of the inner components and the possible presence of water droplets. In Figure 2, an example of condensate on a headlamp lens is shown. The presence of condensate inside the headlamp is perceived by the customer as a lack of quality and reliability.



A possible solution for condensate formation is seen in anti-fog coating. Here, a layer of hydrophobic material painted on the inner side of the lens prevents the water to stick onto the plastic walls. Another solution is the use of a hydrophobic membrane applied to large vent holes. In this way, high air flow rates are allowed to pass through the membrane but the headlamp is kept sealed with respect to humidity. The drawbacks of these methods are the strong impacts on the cost per piece and on the cycle-time.

These solutions are generally applied to luxury and high-performance cars where cost and production volume are not so relevant. The most used solution for decreasing condensate quantity and disposal time is represented by the optimization of inner air flows and of temperature distribution on the main lens. Typically, at least two vent holes are located on the headlamp housing. In order to optimize their efficiency, it is important to find the right numbers and locations by performing numerical and physical tests during the pre-industrialization phase. In Figure 3, an example of vent holes in the headlamp housing is shown. Until today, the right solution to condensate formation has always been sought by trials and error. This implies a great increase in time and costs. In this context, the use of appropriate numerical methods and test rooms becomes a strategic tool for decreasing production time and cost and, in the near future, for optimizing headlamp design with respect to condensate formation and disposal.

From a fluid-dynamic point of view, an automotive headlamp can be considered as a cavity with low mass-flow interaction but high thermal interaction with the external environment. One wall of the cavity, the lens, is transparent while the others are opaque. Inside the headlamp there are one or more lamps and a number of components: reflectors, screens, caps, connectors, pipettes, etc. These components are used for the functionality of the headlamp but, in the meanwhile, play a fundamental role in the thermo-fluid-dynamic behavior of the fluid inside the headlamp which is a mixture of air and water vapour. The headlamp can undergo phenomena of heating and cooling because of internal and external heat sources. The external heat sources or sinks are represented by the external environment temperature or by the heating coming from the engine. The internal heat source is represented by the switched-on lamp which heats up the surrounding fluid and emits radiation. Since

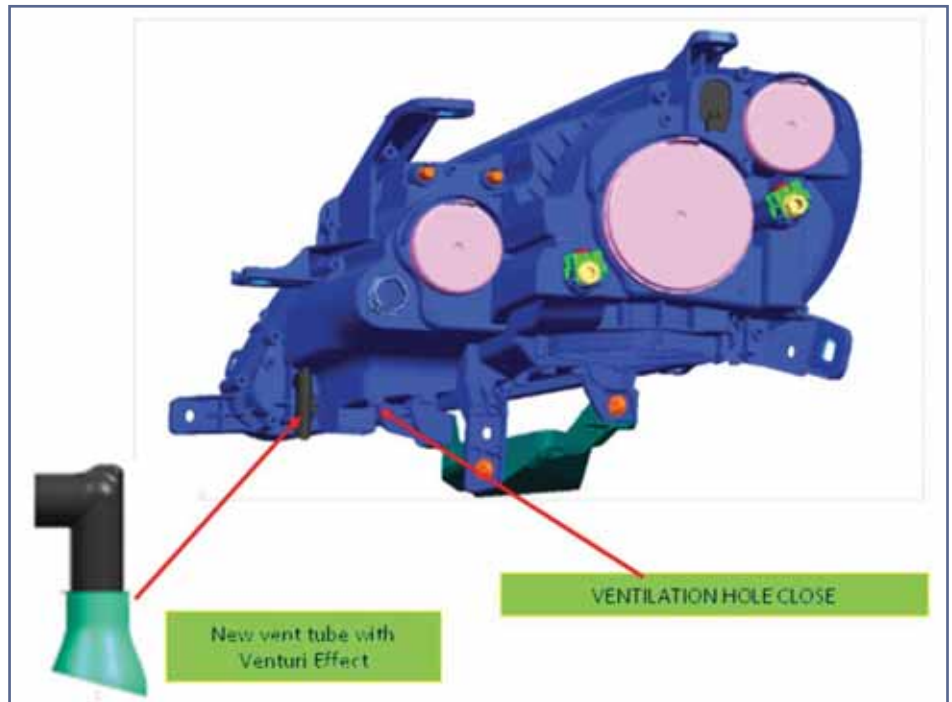


Figure 3. example of vent holes on the headlamp housing

the fluid inside the headlamp is composed of a mixture of air and water vapour, it changes density because of thermal evolution. Density differences are the cause of internal convective motions which are always laminar. Since temperature is, in final analysis, the engine of the motion of the internal fluid, it is important to precisely and accurately characterize all the components of the headlamp. They are to be characterized both from a thermal and an optical point of view, in order to model temperature, heat transfer to surrounding fluids, radiation absorption, emission and reflection.

Moreover, the assembly of all components delimits the space where fluid can flow, and hence determines the motion field inside the headlamp. All components should be modelled with a geometrical detail adequate to the level of accuracy desired for the fluid-dynamic results. On the other hand, a great geometric detail leads to a large mesh and hence to large computational costs.

The right trade off between geometric details and computational costs has to be achieved. In addition to this, temperature evolution of the headlamp may cause water phase changes; in particular it may cause water condensation and evaporation on the lens which is a main issue for headlamp producers and the target of the present work.

The problem to be studied is a typical multi-phase problem for which it is important to properly describe the phase change between liquid water and water vapour. Given this problem, it is important to properly describe the natural convection velocity field due to different density of fluid masses inside the headlamp. For this reason, it is important to account for gravity and buoyancy effects in the fluid. Since the motion field is



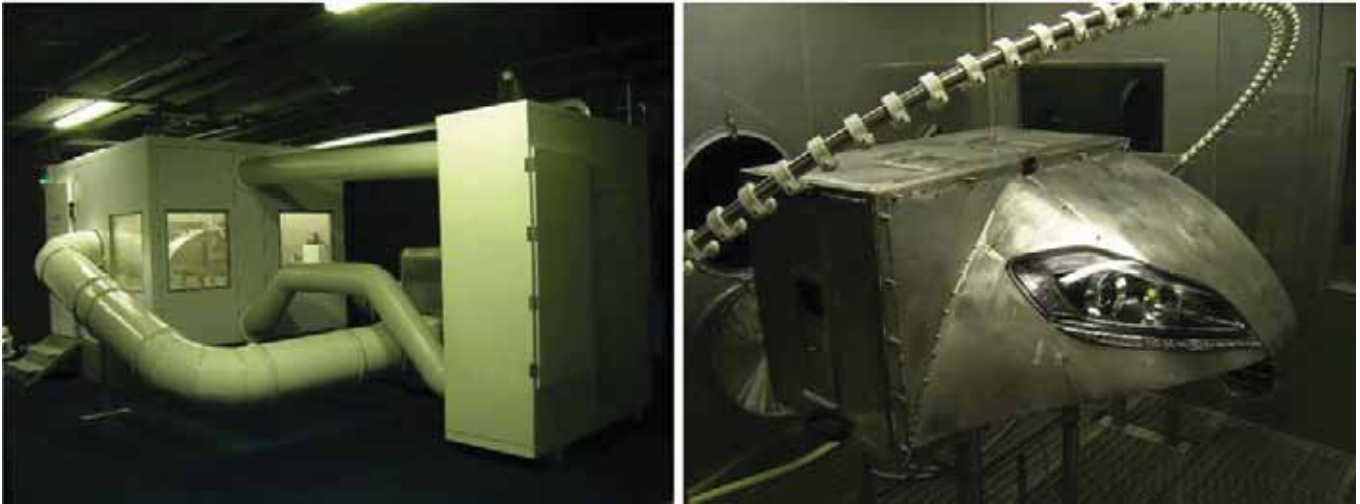


Figure 4: ALIT condensate test room (left) and engine box mock-up inside the room (right)

driven by natural convection, the flow is laminar and no turbulence model is used. Another important phenomenon to be modelled is the heat transfer between walls and fluid, between different fluid masses and, particularly, the latent heat absorbed by water evaporation and released by vapour condensation. Finally, when a switched-on lamp is considered, thermal radiation is to be accounted for.

In order to study the condensate phenomenon inside an automotive headlamp, a series of experimental and numerical tests have been performed on specifically designed prototypes in which the condensation process was enhanced. In what follows, one of these tests is presented in details.

## EXPERIMENTAL STUDIES

### *History of condensate tests*

Headlamp reliability verification with respect to condensate effects started in the early '90, with the introduction of clear lenses and plastic materials. Soon afterwards, customer specifications included the same. The first step was the introduction of some verification criteria on the basis of pre-existent tests. These criteria involved the absence of water droplets inside the headlamp during the standard sealing and rain tests. Nevertheless, these tests were not conceived to check the specific worst condition for the condensate formation but usually to test tropical rain and ford conditions. Indeed, they were mainly focused on discovering any eventual lack on the headlamp sealing and not on the inner air flux optimization. A typical tropical rain test is performed at ambient temperature higher than 24°C which is far from the cold and foggy conditions for condensate formation. Consequently, specific tests, more and more severe, have been performed to understand and prevent any possible defects. Obviously, this process required some years to reach a deeper understanding of the phenomena and to introduce some technical solutions, such as, for example, the introduction of vent pipes, hydrophobic membrane and anti-fog coating.

The first condensate tests were driving-tests, a powerful but hardly reproducible method for taking into account all the variables of the system, such as interactions between engine components and headlamp. The influence of the external air properties, such as temperature and humidity did not allow to schedule a test campaign. It then became necessary to perform tests in a controlled environment, such as a wind tunnel facility using a full scale vehicle. In this way, it was possible to control all the key factors of the condensate dynamics looking for the worst condition and, at the same time, without losing the coupling effects of the car assembly. However, this method is very expensive because of the high cost of facility maintenance and use; the obvious consequence is that only a low number of tests is possible. It was then necessary to find another way for testing different project solutions and prototypes, in order to deeply understand the condensate phenomena. Automotive Lighting Italy (ALIT) designed a specific condensate test room, able to reproduce and control all the main factors involved in the phenomenon under study. The condensate test room allows for:

- Product Validation – in house HL performances evaluation allows the adoption of corrective actions (if needed) before the test is performed in the presence of the customer;
- Prototype Evaluation – several in house tests are possible in order to test different and/or innovative solutions for new projects;
- Benchmark – in house tests are possible in order to evaluate competitors' solutions;
- Simulation – full availability for all necessary tests used for software calibration.

### *Test description*

Condensate tests are usually divided into three main steps. A first conditioning period is followed by a condensate formation stage; after that, the condensate disposal step is performed. For this last step, a time threshold is usually fixed. In Table 1, the condensate test steps are described in detail.



Condensate tests are considered successful if, after 60 minutes from the beginning of stage 2, condensate is not visible inside the headlamp or if the percentage of lens surface covered by condensate is lower than a prescribed value.

1. Headlamp conditioning	The prototype, mounted on car or engine-box mock-up, is placed in the room at 5±2 °C and 95% RH	About 12h
2.a. Condensate formation	Headlamp lamps are switched-on	About 20'
2.b. Condensate formation	A rain effect is induced: water at 8°C is spray on the prototype and a wind speed of 30Km/h is introduced. Engine works at low regime with engine box at 30°C. The same air conditions as before are used	About 20'
3. Condensate disposal	External air at 5±2 °C e 95% RH, air speed at 80 Km/h and engine box at 50°C without rain	Until complete disposal

Table 1: condensate test description

**ALIT Condensate Test Room**

ALIT Condensate Test Room is a metal room with a volume of about 30m3 (see Figure 4). Glass windows allow the technicians to follow the ongoing tests. By using a dedicated hardware, it is possible to control all the main variables related to the condensate disposal process, such as:

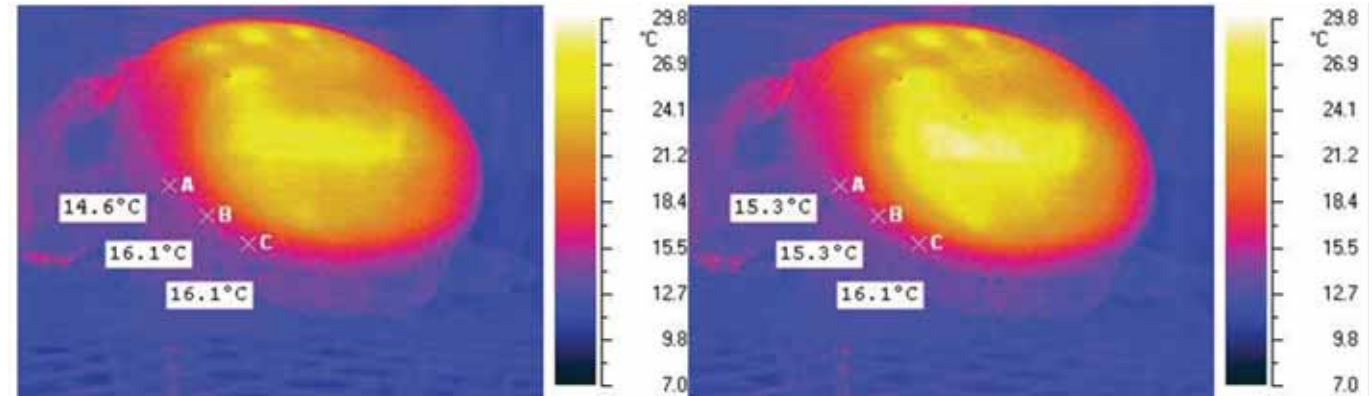


Figure 5: thermal maps on the lens at two different times

- Heat Transfer Coefficient (HTC) on headlamp boundary walls;
- Internal and external air relative humidity (RH);
- Internal and external air temperature;
- Pressure and air flow fields in the proximity of ventilation pipettes;
- Mission profile reproduction accounting for engine induced temperature and wind speed;
- Interaction between headlamp-engine assembly.

ALIT condensate test room is projected to control all the main factors involved in the HTC distribution. It is possible to control external air RH and temperature. Moreover, an air speed of up to 80Km/h can be produced along the longitudinal car axe. Inside the room, an engine box mock-up reproduces the effects of the average temperature produced by the engine.

Since HTC is influenced by aerodynamic effects too, the engine box mock-up reproduces the car shape (see Figure 4). At present, the effects not reproducible are represented by pressure and air flow fields inside the

engine box. Indeed, geometric and thermodynamic effects of the engine are still too complex to be reproduced. Nevertheless, a good approximation is obtained by using an average temperature inside the engine box mock-up.

**Measure devices**

A major problem related to the condensate issue is the difficulty of an objective condensate tracking. Indeed, large variations in condensate layer thickness as well as in water droplets diameters may occur and this has a direct influence on the perception of the human eye. The use of a standard photographic camera with flash usually highlights even the smallest traces of condensate which may not be visible for the human eye. At the same time, it is not possible to measure a continuous distribution of the dew point.

Several temperature and humidity probes are present inside the ALIT condensate test room, these are located in the free-area zone and inside the engine box mock-up. Moreover, it is possible to place thermal couples and moisture meters inside the headlamp in order to get punctual data. Finally, temperature distribution on the

lens is tracked by means of an infrared camera. By combining these data together with photos and videos of condensate distribution it becomes possible to track the dew point line. Currently, it is not feasible to measure condensate thickness.

**Test Results**

The outputs of the condensate test are:

- thermal maps and videos shot using an infrared camera (Figure 5);
- condensate images and videos shot using photographic camera with flash (Figure 6);
- temperature and relative humidity graphs measured by the thermal couples and moisture meters placed inside the headlamp, inside the engine box mock-up and in the external environment (Figure 7).

From Figure 6 it can be noticed that condensate tends to accumulate on the outer side of the headlamp (left side of the figure) which is the coldest part of the lens, as showed in Figure 5.



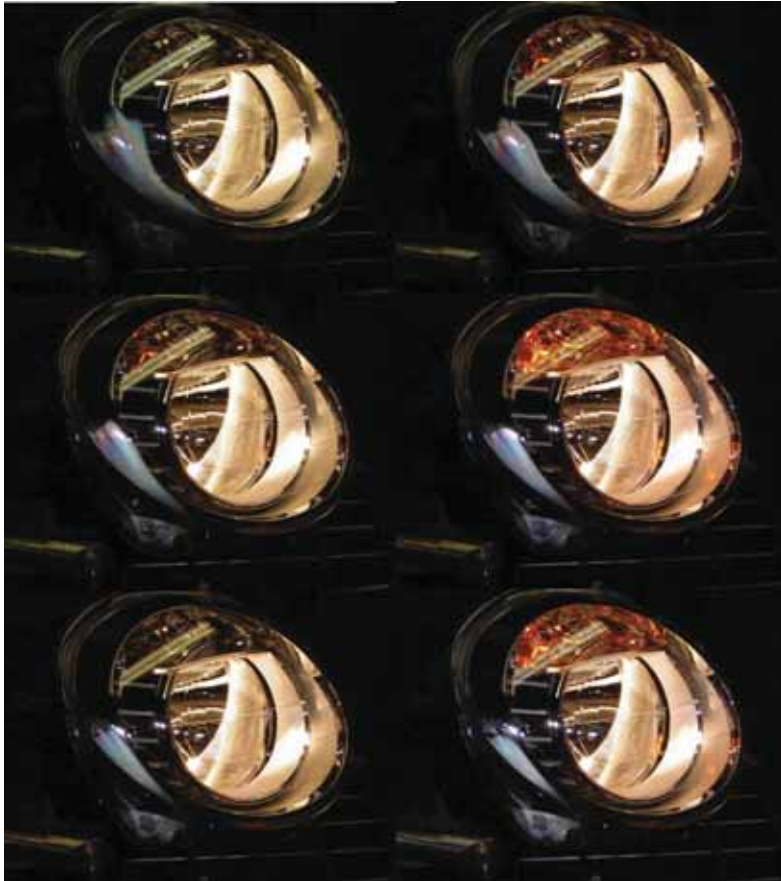


Figure 6: condensate images at different times

**NUMERICAL SIMULATIONS**

**The Numerical Method**

When a switched-on lamp is to be modelled, a radiation model has to be used in order to compute the source term for the energy equation and the radiative heat flux at walls. In the present work, the Discrete Transfer model is used for the directional approximation and the Grey model is used for the spectral approximation. The Gray model assumes that all radiation quantities are nearly uniform throughout the spectrum, consequently the radiation intensity is the same for all frequencies.

The Discrete Transfer model assumes that the scattering is isotropic. The switched-on lamps are modelled by imposing the superficial temperature of the lamp bulb; surface temperature data come from experimental measurements.

In the considered evaporation/condensation model, the liquid phase is not directly modelled. Instead, the evaporation/condensation processes occurring on the lens are modelled by means of suitable mass and heat sources for the continuity and thermal equations. The mass source term applied to the conservation law for water vapour mass in the gas is:

$$S_M = \dot{m}A = \frac{\pi L \mu Sh (e - m_f)}{A_i} A.$$

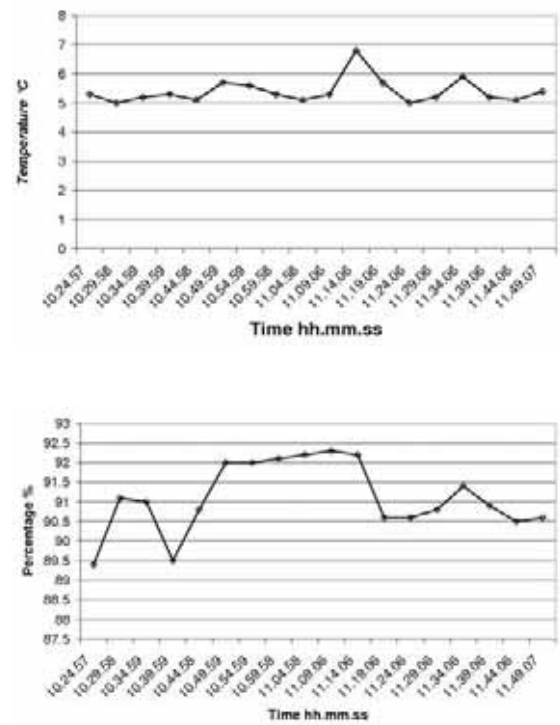


Figure 7: temperature and relative humidity graphs in ALIT Condensate Test Room

Here  $\dot{m}$  is the water mass per unit area transferred between liquid and gas,  $A$  is the area of the element face where evaporation and condensation processes occur,  $A_i$  is the total area of the surface where evaporation and condensation processes occur,  $L$  is the typical length scale of the process,  $\mu$  is the diffusivity of water vapour in the air, considered equal to the air dynamic diffusivity,  $e$  is the water mass fraction at equilibrium,  $m_f$  is the water mass fraction and  $Sh$  is the Sherwood number.

The air volume fraction is the complement to unity of the computed vapour volume fraction. The energy source due to phase change applied to the conservation law for internal energy is:

$$S_E = -\dot{m}C_p,$$

where  $C_p$  is the water latent heat for vaporization/condensation. Mass and energy sources are applied only at surfaces where evaporation/condensation processes occur.

In the framework of this evaporation/condensation model, it is possible to define the water mass per unit area laying on the lens as:

$$m_w(\mathbf{x}, t) = m_w(\mathbf{x}, 0) - \int S_M(\mathbf{x}, \tau) d\tau.$$

Here the space and time dependency of the water mass per unit area is explicit. This variable allows for a precise tracking of the condensate amount laying on the lens.



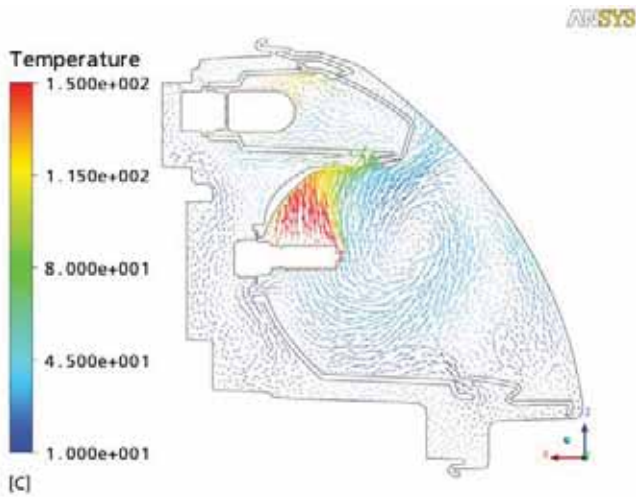


Figure 8: velocity vectors on a vertical plane passing through the lamps (note that vectors are coloured with temperature distribution)

Moreover, in the case of evaporation, the local mass source has to be null where local water mass per unit area is null; this is achieved by a local control of the mass source term.

Mass and energy sources are implemented in ANSYS CFX by means of properly defined functions and variables using the CEL language. The analyses were run using an upwind advection scheme and a backward Euler transient scheme was ordered first. Moreover, the time step and the convergence criteria were chosen in order to minimize the computational time without compromising result quality and method robustness.

**The Computational Mesh**

Solid and fluid domains were discretized using a tetra-prism mesh. In particular, prism layers were used inside each solid domain and outside the rear body, the lens and the lamps. A total of about 1.750.000 elements were used to discretize the entire headlamp.

**Initial and Boundary Conditions**

At the initial time, the lamps are switched off, the temperature is 6°C and the relative humidity 95%. At the beginning of the simulation, lamps are switched on. After 20 minutes rain starts. After 40

minutes rain stops and wind at 30 km/h starts blowing until the end of the simulation at 60 s. These conditions are simulated by varying external temperature and relative humidity together with HTC on the lens. The initial and boundary conditions used in the simulation are summarized in Table 2.

0 min	Temperature = 6°C Relative Humidity = 95%
0 min → 20 min	Uniform temperature distribution on the lamps and radiation model External temperature = 6°C External relative humidity = 95% HTC on the lens = 10 W/m <sup>2</sup> K
20 min → 40 min	Uniform temperature distribution on the lamps and radiation model External temperature = 6°C External relative humidity = 100% HTC on the lens = 500 W/m <sup>2</sup> K
40 min → 60 min	Uniform temperature distribution on the lamps and radiation model External temperature = 6°C External relative humidity = 95% Variable HTC on lens

Table 2: initial and boundary conditions

**Results**

The simulation was run on 32 parallel CPUs with OS Linux CENTOS. The computational time was roughly 12 days. In Figure 8, velocity vectors on a vertical plane passing through the lamps are shown; note that vectors are

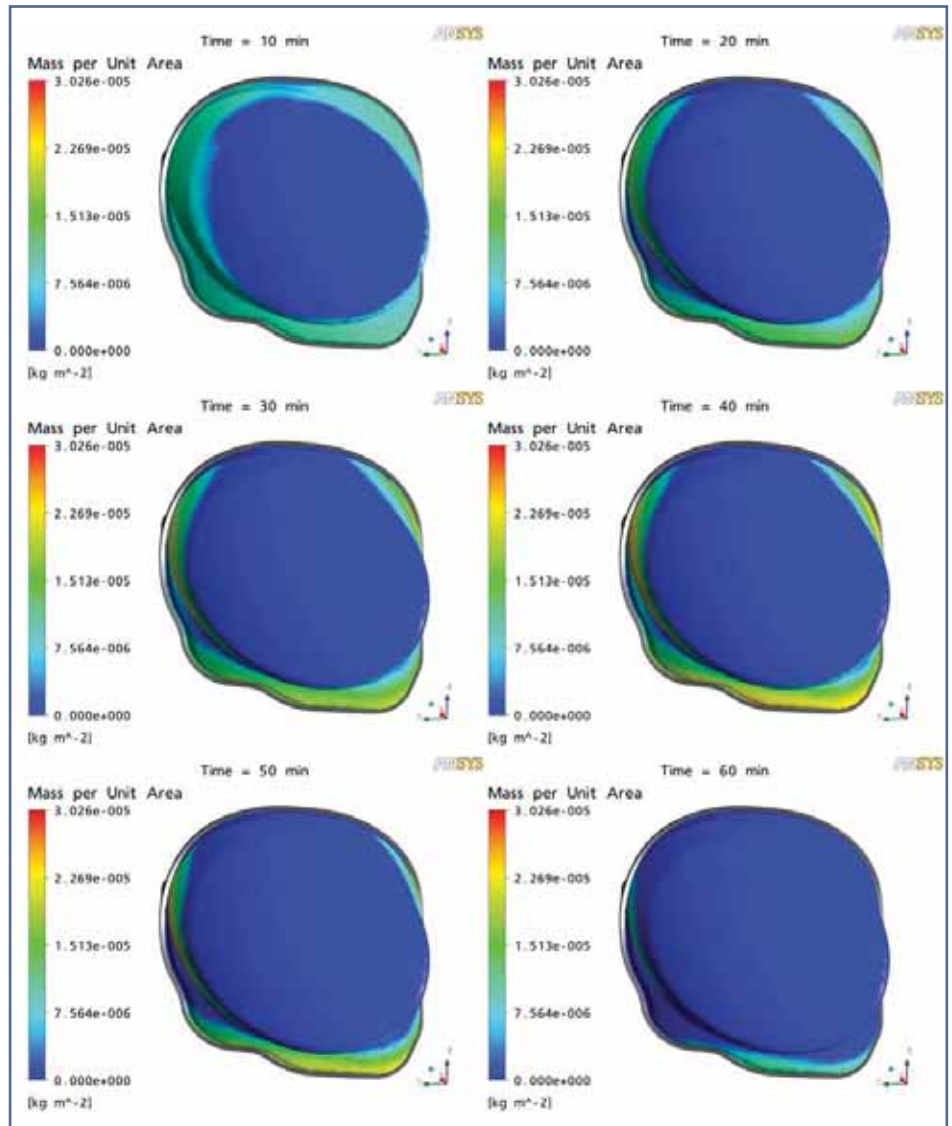


Figure 9: time evolution of condensate mass per unit area



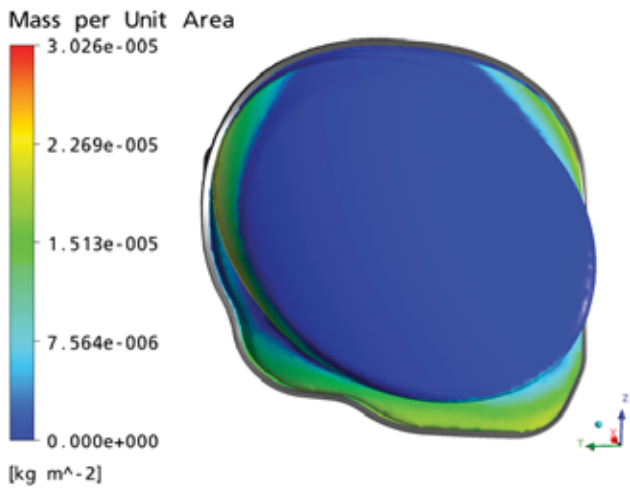


Figure 10: qualitative comparison between numerical and experimental results

colored with temperature distribution. In Figure 9, the time evolution of condensate per unit area on the lens is presented. The strong buoyancy effect caused by the switched-on lamps can be appreciated in Figure 8. Furthermore, from the same figure, the complexity of the geometry of the inner part of an automotive headlamp may be appreciated: this is made up by a number of parts that strongly affect the inner velocity field.

Moreover, from Figure 9, it can be noticed that condensate tends to accumulate on the outer side of the headlamp (left side of the figure), where heating from the lamp is limited as well as natural convection.

## CONCLUSIONS

Because of the difficulties in measuring condensate mass on the lens, at present, only a qualitative comparison can be made; in Figure 10 such a comparison is presented. It can be noticed that the two results are in good agreement highlighting a region of condensate accumulation in the outer side of the headlamp.

It has to be emphasized that some sensitivity analyses showed a strong dependency on initial and boundary conditions demonstrating the complexity of the phenomenon under study and the need of strongly controlled experimental conditions. Due to the complexity of the problem, numerical simulations are to be performed for a long period and on large meshes, so that a high computational power is needed. Nevertheless, numerical simulations are capable to give detailed information on the thermo-fluid-dynamics of the headlamp taking into account the condensation/evaporation phenomena that may occur on the lens.

In particular, numerical simulations clearly highlight the critical areas of a headlamp design with respect to condensate formation and disposal. These information can be made available before any real headlamp is produced



thus reducing the number of prototypes. Moreover, by superimposing numerical results and condensate images taken from the experimental tests, it is possible to correlate results and to get important information about the condensate issue in terms of distribution and thickness of the water layer.

The combined use of numerical and experimental studies is a powerful tool for optimizing headlamp design and obtaining high performance headlamps.

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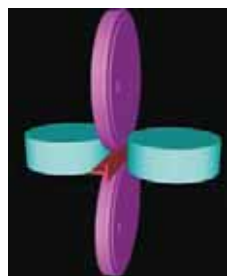


# Gruppo Beltrame: avanguardia tecnologica e innovazione



GRUPPO **AFV** BELTRAME

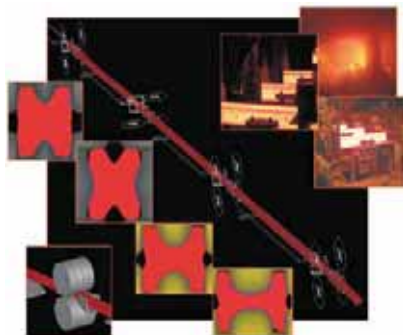
Il Gruppo Beltrame è leader in Europa nel mercato dei laminati mercantili ed è altresì un primario produttore di profili speciali per i comparti della cantieristica navale e del movimento terra. Gli impianti, che hanno una capacità produttiva di circa 4 milioni di tonnellate, sono costituiti da quattro acciaierie a forno elettrico e da quindici laminatoi, localizzati in undici stabilimenti ubicati in Italia, Svizzera, Francia, Belgio, Lussemburgo e Romania. La capogruppo, Acciaieria AFV Beltrame di Vicenza, ha installato un ciclo "mini-mill" completo, con forno elettrico da 130ton per trasformare rottami ferrosi in colata continua di acciaio, con due treni di laminazione in grado di produrre un sagomato molto completo di laminati mercantili e laminati speciali. Tutto il personale, oggi circa 3000



dipendenti, è fortemente impegnato e motivato a soddisfare la clientela tramite un costante miglioramento nell'ambito della produzione, dell'organizzazione e dei servizi. Tensione innovativa, cultura della produttività e della qualità sono stati obiettivi costanti nelle scelte strategiche che hanno portato il Gruppo Beltrame al primato italiano e poi alla leadership europea nel proprio comparto. Visitate il sito del Gruppo Beltrame all'indirizzo: [www.beltrame.it](http://www.beltrame.it)

## La scelta di EnginSoft e di Forge Cluster

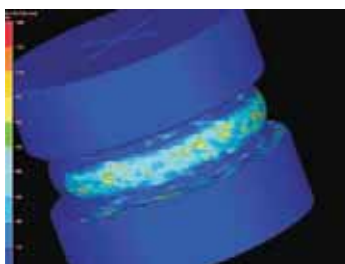
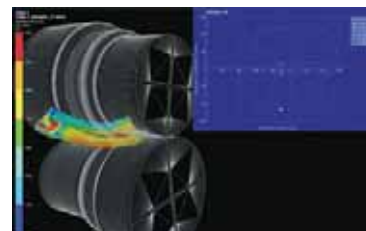
Nella costante ricerca di strumenti che potessero rendere più accurata la progettazione dei treni di laminazione e la calibrazione delle sezioni, AFV Beltrame ha intuito come i software di simulazione di processo possano essere uno strumento per la verifica di fattibilità dei processi, dei componenti e nella messa a punto delle attrezzature. Individuato il software Forge come candidato possibile per affrontare il complesso problema del comportamento di un treno di laminazione, lo strumento è stato messo alla prova, sfruttando l'esperienza di EnginSoft, con simulazione delle singole gabbie e di un treno di laminazione di 4 gabbie in successione di un profilo IPE. Per ogni stazione sono state introdotte condizioni critiche quali entrata della bramma preformata, tramite guide, in posizione di fuoricentro o inclinata, in modo da valutare effetti di incurvamento della barra e/o asimmetrie di sezione. Il modello utilizzato in Forge tiene conto della variazione del comporta-



mento del materiale in funzione della modifica puntuale della temperatura, della velocità di laminazione e della deformazione accumulata, quindi consente di tener conto in modo preciso del flusso del materiale conseguente alla pressione esercitata dai rulli e dalle guide. La flessibilità nell'impostazione di modelli di simulazione con cinematiche anche complesse ha consentito di riprodurre con la massima precisione il movimento di rotazione dei rulli e le condizioni di tiro spinta che vengono registrate nel processo reale. I risultati ottenuti (forma delle sezioni, incurvamento della barra, forze e coppie sui rulli, ...), hanno mostrato come sia possibile la verifica di una sequenza di laminazione anche complessa mediante la calibrazione delle singole gabbie in successione, in tempi molto rapidi, e quindi la validazione dell'intero processo mediante un calcolo finale dell'intero treno. Il confronto con le evidenze sperimentali ha convinto Beltrame a dotarsi in tempi molto rapidi del software Forge nella sua versione per Cluster 16 Core.

## Come viene oggi utilizzato Forge in Beltrame

Dalla formazione di base all'uso del programma, con EnginSoft che ha affrontato con i tecnici già dei casi concreti, si è rapidamente passati ad un affiancamento metodologico su progetto, mediante il quale i tecnici sono stati guidati all'interpretazione dei risultati e ad un utilizzo più avanzato di Forge. Sono stati simulati casi via via più difficili, passando da semplici profili IPE alla laminazione di soles con sagome complesse e problemi di incurvamento e quindi di cinematiche avanzate quali le gabbie universali ove l'interazione tra due cilindri motore e due folli consente di ottenere profili anche molto articolati. Luciano Grigoletto, responsabile a Vicenza per la progettazione delle sequenze di laminazione, in un recente incontro ha dichiarato come "i risultati delle simulazioni, uniti alla grossa esperienza accumulata in tanti anni di prove, stanno rendendo molto più rapida ed accurata la valutazione di nuovi prodotti, riducendo il tempo necessario per calibrazione e la messa a punto di nuove linee. La scelta della versione Cluster è stata dettata dalla necessità di svolgere un notevole numero di simulazioni in breve tempo ed EnginSoft ci sta accompagnando con precisione nell'utilizzo del software, guidandoci nell'interpretazione dei risultati ed in un uso più avanzato del software.



Da quanto visto finora siamo convinti che la strada intrapresa sia quella giusta per consentirci quella crescita e miglioramento continuo del nostro "Know How" sui processi, punto chiave nel quale AFV Beltrame vuole confermarsi leader del settore".



Testimonial



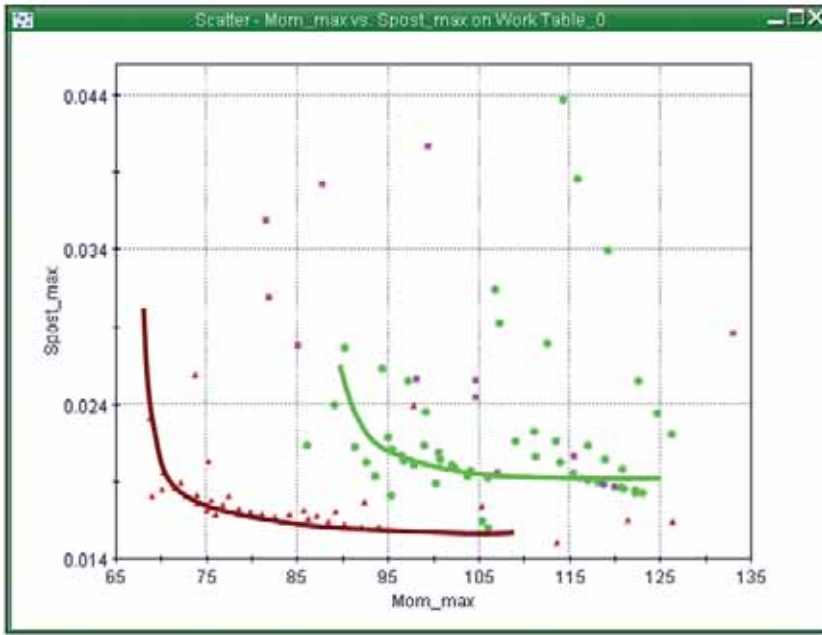


Figure 2: Example of Objective Scatter Chart for two conflicting objectives with representation of the Pareto Frontier where: ■ 2 levels of anchors ● 3 levels of anchors ▲ 4 levels of anchors

created by the CeAS Group to analyze different situations in designing walls, in order to let the optimizer work without human intervention. Since Paratie had never been coupled with modeFRONTIER, it was necessary to create an interface via a DOS BATCH SCRIPT node. Thus only text files are integrated in the workflow created.

**Results**

Approximately 2000 different configurations of the system were developed by modeFRONTIER, and the optimal Pareto Frontier was obtained. This consists of 102 configurations, which, in the light of an easier interpretation of results, are divided into three groups with respect to the number of levels of anchors integrated into the system (Figure 2).

The choice of the optimal design solution from an engineering perspective has to be guided by further considerations including:

- it is essential to know the environmental conditions of the area where the structure is going to be build; e.g. if this walls are in urban areas, as frequently happens, the design is governed by the displacements of the system.
- In general the overall lateral displacements and main bending moments of the systems are influencing the choice (Figure 3).

Once a group of solutions suitable for the site conditions

is selected, it is easy to complete the analysis with Paratie and so to obtain the necessary charts.

**Conclusions**

The model: This way of designing is highly innovative, particularly for the possibility offered by modeFRONTIER to combine different operations in a single work environment. The model created represents not a goal but a starting point, is but to be treated as a starting point and has to be accepted on the basis of engineering judgment.

The softwares: Both softwares proved good performances: Paratie turned out to be the ideal tool for this kind of analysis in terms of operating time and results obtained (the nature of the files it manages), even if the applicability of the Winkler model for the beam-soil interaction has to be accepted by case basis. modeFRONTIER is an excellent

platform for both the integration of a variety of CAE tools and to perform MDO tasks in a easy and straightforward manner. Moreover the learning curve of the method is amazingly short.

The optimization results: The objectives and constraints defined allow extraction of a reduced group of results in comparison with all the possible configurations that the structure can assume and the designer can choose the most appropriate solution in according with his/her own sensitivity and experience.

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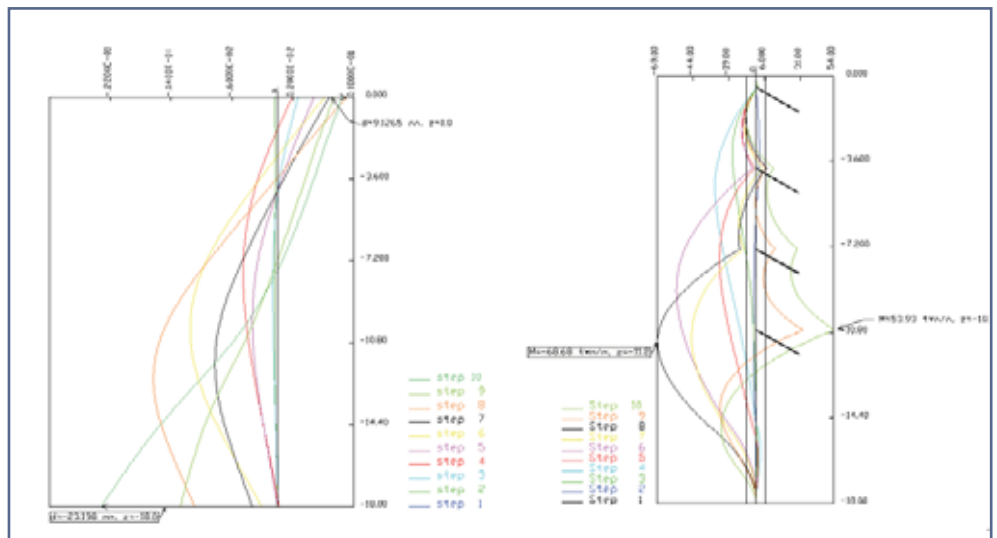


Figure 3: Example of charts describing the lateral displacements (left) and the bending moments (right) extracted from Paratie



# Polestar Racing AB – European Saloon Car Racing “Made in Sweden”

The motorsports world and specifically the saloon car racing sector, are where technological excellence and engineering know-how meet with passion for vehicle performance, precision and speed.

Polestar Racing AB based in Göteborg, Sweden, is responsible for all major activities of Volvo in the motorsports field. The company manages the design, development and operation of Volvo racing cars, including power optimization, but also the hosting of stunning motor racing events throughout Scandinavia as well as training courses for Volvo car dealers.



*Polestar Workshop with Per Blomberg, Engineer Chassis Development, and Expert Mechanics*

Polestar Racing also dedicates resources to the younger generation, to students at secondary schools and universities, to foster interest in automotive engineering.

When it comes to Virtual Prototyping and CAE Computer Aided Engineering, Polestar applies various state-of-the-art technologies and methods for the design, development and testing of the bodywork, engine, roll cages and suspension components of Volvo’s racing cars.

With the aim to enhance specifically chassis dynamics, aerodynamics and brakes through multi-objective optimization with modeFRONTIER, Polestar has recently entered into a collaboration agreement with Esteco (EnginSoft) Nordic AB which will see the two companies cooperating intensively to their mutual advantage in the months ahead.

Christian Dahl, Managing Director of Polestar Racing, spoke to us about ambitions that he and his teams have for the future:

Christian: “Polestar Racing currently is supported by a team of over 20 highly competent and ambitious engineers and professionals. Every team member has been trained inside our company from the very beginning. Unlike most of our competitors in the STCC Swedish Touring Car Championship, we develop and enhance our technical competencies internally. Moreover, the vast majority of our technology partners is based in the country; hence, it is no surprise that our collaboration model carries the name “Made in Sweden” but in a true European spirit!

In 2008, when Volvo decided to compete with its C30 race car model that Polestar should develop, we practically grew by 30% overnight - to meet the challenge. As one of the first players in the business, Volvo and Polestar agreed to use E85 bio-ethanol. A silver medal in the 2007 Championship was the reward.

Our ambition for the future is to maintain Volvo’s leading position in the European Saloon Car Racing market and to target more and more also international championships consistent with our companies’ three core values: Safety, Quality and Environment”.

*Christian Dahl, Polestar Racing AB,  
Göteborg - Sweden*



*C30 Volvo Racing Car running on 100% E85 Bio-Ethanol*

# Aerodynamic optimization of the Volvo Polestar Olsbergs Green Racing C30 using modeFRONTIER

## The Rationale

Motorsport is a highly competitive environment where performances, time and budget represent conflicting objectives. Polestar, racing in the Swedish Touring Car Championship with two Volvo C30 OGR, has to cope with them.

To this extent, a challenging task of primary importance is to establish a tool that may help race engineers in finding the car aerodynamic optimal configuration directly on the track in real time, using a limited budget and a clever experimental campaign to tune it.

modeFRONTIER has played a crucial role in meeting these objectives.

First, it allowed to achieve significant experimental campaign cost reduction by selecting a small but highly meaningful set of experiments to be performed in the Volvo moving ground wind tunnel facility. Then, modeFRONTIER's sophisticated interpolation models have been trained and fitted to such wind tunnel data. Now, they are powerful real-time tools in the hands of the Polestar race engineers, supporting them to forecast the behavior of their C30 OGRs with different set-ups and in any track condition. All this helps the Polestar team to compete at the maximum level in their championship: so far, the results are thrilling, with a first and second position for the two team cars, both in qualifying and at the finish line, in the 2009 season-opening race at Mantorp Park.

## The Challenge

Getting a detailed knowledge of the aerodynamic behavior of a race car is complex and expensive. Complex, since there is a large number of sensitive parameters to be taken into account: managing efficiently multiple parameters requires



Figure 2: Polestar C30 OGR in the moving-ground Volvo wind tunnel

adequate methodological tools. Expensive, since accurate wind tunnel tests are costly and normally facilities have limited availability in terms of time and sessions: a wind tunnel similar to the one considered here costs more than 2500€/hour just for the facility rental.

In fact, to measure accurately drag and down-forces and hence train a reliable prediction model, a full-size wind tunnel facility is required. Moreover, the moving ground allows to capture the "close to ground" effects, which are essential in racing cars. In such facilities, the test car wheels are placed on a steel belt that simulates the road under the moving car, while a fan is blowing the air with the requested speed and direction. This allows to load up the wheels and tires exactly as they are when driving on the open road. The Volvo Wind Tunnel with "moving ground" has been exploited to carry out a test campaign: this facility provides 5.3m-long and 1m-wide steel belts, and a 5 MW fan capable to generate wind velocities corresponding to road speeds of up to 250 km/h. Transferring the gained knowledge to the race track

could be even more challenging: reliable but lean predictive models should be able to forecast aerodynamic car behavior (outputs) at any given car setup (inputs), with the minimum number of wind tunnel experiments required to tune them.

Typical outputs are car drag ( $C_d$ ) and down-forces on the front ( $C_{lf}$ ) and on the rear ( $C_{lr}$ ) axles, while input parameters defining a race car aerodynamic set-up are the ground clearance of the front ( $G_{cf}$ ) and rear axles ( $G_{cr}$ ), angle of attack of the rear wing ( $\alpha$ ), and so on.

## The Solution

All these challenges have been tackled by Polestar Racing thanks to the modeFRONTIER software: complete and fast aerodynamic prediction models of

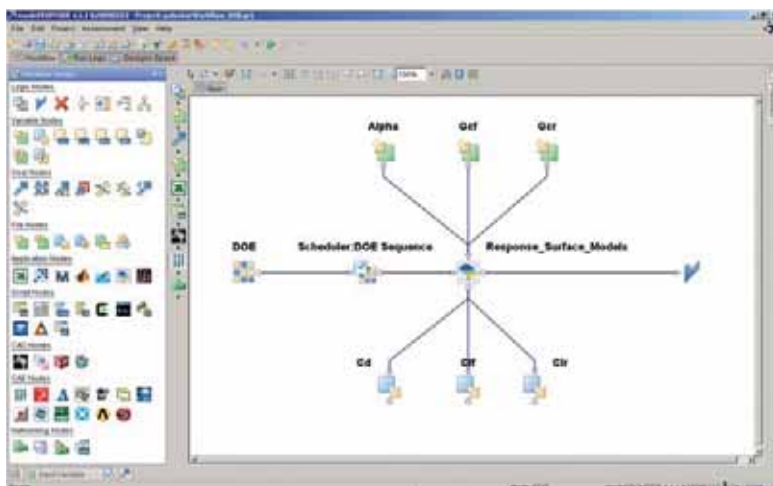


Figure 3: modeFRONTIER software Graphical User Interface

the C30 OGR have been produced, based on few well-selected wind tunnel tests, to be used on-the-field by race engineers.

First, some meaningful experimental data are needed to "train" such predictive models. Having only a wind tunnel test session available, modeFRONTIER has been used to define a reduced but meaningful set of experiments out of the high number of possible car aerodynamic configurations to be tested. This can be achieved by varying simultaneously all the considered parameters, in the most diverse and uncorrelated way. This technique is known as "Design Of Experiments", and here a "Factorial" sampling mechanism has been used: it allows to detect, for each output, the influence of each variable separately (main effects), and also their interactions.



Figure 3: Tim Walker, responsible for Vehicle Aerodynamics at Volvo Car Corporation, and the wind tunnel fan

model that describes each one of the outputs (drag and axle down-forces) as a function of the input parameters (ground clearance of the front and rear axles, angle of attack of the rear wing, etc.) at a given condition (car speed and direction, etc.), has been built by interpolating the available data. To do so, a set of state-of-the-art reliable interpolating techniques, known as "Response Surface Models", are available in modeFRONTIER together with easy tools to judge their quality in terms of relative errors when used for forecasting.

A reliable set of such models have been produced and then exported into MS Excel worksheets, thanks to the dedicated modeFRONTIER interface. They are now being used by the race engineers, to support them in finding the optimal set-up of their C30 OGR in real time at the track side.



Figure 4: Aerodynamic set-up parameters (inputs) and aerodynamic forces (outputs) on the C30

Therefore, only very few car aerodynamic set-up configurations have been tested in the wind tunnel, with a considerable budget and time-saving while achieving the requested quality of extracted information. For each car aerodynamic set-up configuration, the drag and down-force outputs have been measured, and data have been transferred back to modeFRONTIER to complete the data analysis. A

### Conclusions

Polestar appreciated the modeFRONTIER capability to handle multi-variable challenges. It allowed to select a reduced but meaningful set of wind tunnel experiments, to characterize the aerodynamic behavior of their C30 OGR. This has led to considerable savings in testing budgets while keeping constant the quality and completeness of the extracted information. Moreover, modeFRONTIER's sophisticated Response Surface Models have been crucial to generate accurate and fast aerodynamic forces predictive models, based on the wind tunnel experiments, to be used directly at the track side through a simple MS Excel interface. This accomplishes the technical goals of the collaboration between Polestar and Esteco (EnginSoft) Nordic.

Polestar Racing couples successfully modeFRONTIER, also with in-house Computer Aided Engineering tools, to improve the car design and set-up thanks to virtual simulations.

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Luca Fuligno, EnginSoft SpA, Italy  
Hakan Strandberg, EnginSoft Nordic AB, Sweden*

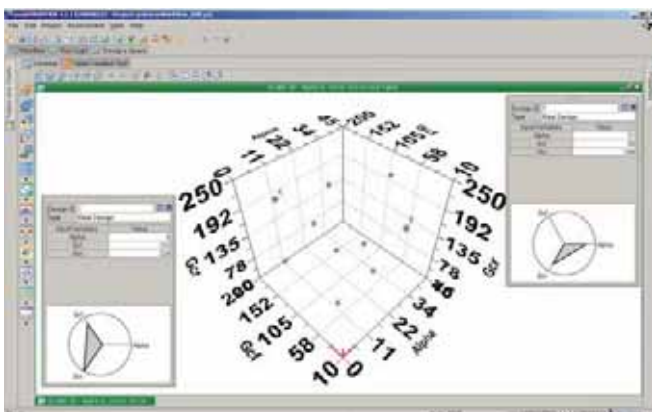


Figure 5: Sketch of a Design Of Experiments in the space of the input variables: each bubble represents a particular combination of parameters to be tested

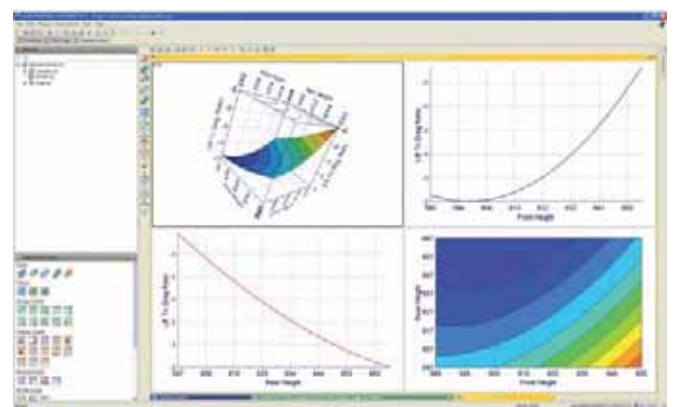


Figure 6: The predictive Response Surface Models of the lift/drag force ratio, trained over a set of available experimental data, plotted as a function of two of the considered input parameters (front and rear car height).

# The current status of research and applications in Multiobjective Optimization

Multiobjective optimization deals with solving problems having not only one, but multiple, often conflicting, criteria. Such problems can arise in practically every field of science, engineering and business, and the need for efficient and reliable solution methods is increasing.

The task is challenging due to the fact that, instead of a single optimal solution, multiobjective optimization results in a number of solutions with different trade-offs

**Interactive and Evolutionary Approaches**  
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**Branke, J.; Deb, K.; Miettinen, K.; Slowinski, R. (Eds.)**  
**2008, XX, 470 p., Softcover**  
**ISBN: 978-3-540-88907-6**

among criteria, also known as Pareto optimal or efficient solutions. Hence, a decision maker is needed to provide additional preference information and to identify the most satisfactory solution.

Depending on the paradigm used, such information may be introduced before, during, or after the optimization process. Clearly, research and application in multiobjective optimization involve expertise in optimization as well as in decision support.

This state-of-the-art survey originates from the International Seminar on Practical Approaches to Multiobjective Optimization, held in Dagstuhl Castle, Germany, in December 2006, which brought together leading experts from various contemporary multiobjective optimization fields, including evolutionary multiobjective optimization (EMO), multiple criteria decision making (MCDM) and multiple criteria decision aiding (MCDA).

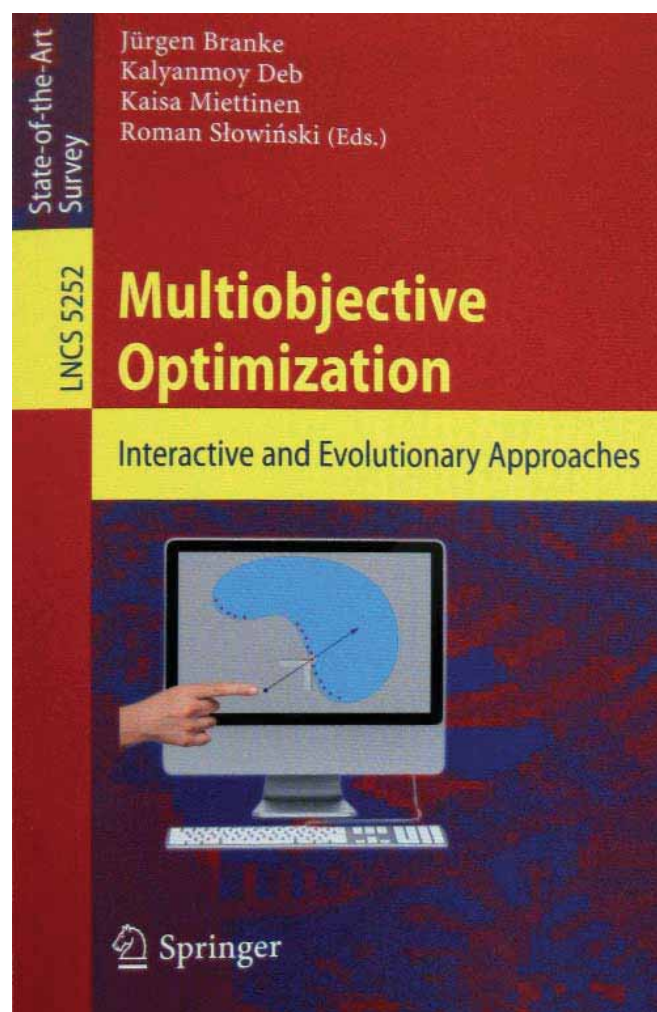
This book gives a unique and detailed account of the current status of research and applications in the field of multiobjective optimization. It contains 16 chapters grouped in the following 5 thematic sections: Basics on Multiobjective Optimization; Recent Interactive and Preference-Based Approaches; Visualization of Solutions; Modelling, Implementation and Applications; and Quality Assessment, Learning, and Future Challenges.

## Written for:

Researchers and professionals

## Keywords:

GUI design, combinatorial optimization, constraint satisfaction problems, decision maps, evolutionary algorithms, evolutionary computation, fuzzy rule, genetic algorithms, heuristics, hybrid methods, information retrieval, interactive methods, knapsack problem, memetic algorithms, metaheuristics, multi-criterion optimization, multiobjective optimization, multiobjective programming, network design, \* optimization, parallel algorithms, parallel exact optimization, parallel metaheuristics, parallel multiobjective optimization, pareto optimal set, project scheduling, reference point approaches, scatter plots, simulated annealing, visualization.



# Handwritten pattern recognition with modeFRONTIER

Each of us has his/her own handwriting. When two persons are asked to write the same text, they may produce two documents which look completely different, even though the content is the same. Moreover, the same person will not produce the same document if he/she writes at two different times. A person's handwriting actually reflects the emotional state, it also strongly depends on the surroundings, e.g. the pencil, pen and paper being used. Figure 1 shows an image with the same simple text written by different persons. It becomes immediately clear that different styles are present. Words can have a "rounded style" or, on the contrary, be rich of corners; characters can be placed closed to or far from each other, they can always look equal in size or be different according to the position assumed in the word, they can be deformed etc. Despite this high degree of variability, we are able to read these texts and understand the meaning of the message. The handwritten pattern recognition is a discipline which tries to automatically recognize an handwritten text contained in an

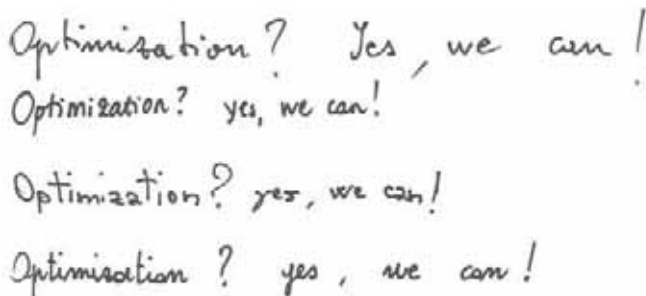


Figure 1: The same simple text written by different persons may appear very different.



Figure 2: Some handwritten alphabets used to build the database used in this paper. It can be easily noted that equal letters can be graphically represented in very different manners.

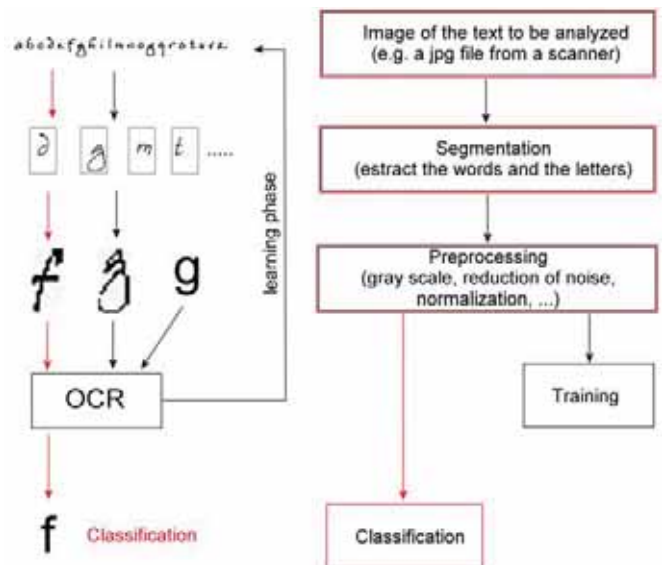


Figure 3: A possible strategy for the handwritten pattern recognition. An image containing the text to be analyzed has firstly to be loaded in the system which starts with the segmentation phase. The words have to be isolated in the text and then they have to be decomposed into letters. Letters have to be normalized and the noise has to be reduced. The training phase (black arrows and boxes) consists in giving to OCR system a certain number of different letters, teaching in this way the "rules" underlying the handwritten recognition. Once the training has been completed the OCR can be asked to classify new letters not contained in the training set (classification phase, red arrows).

image and translates it into an editable text, written with a unique standardized font, making it available for further modifications. The result should be a machine (a series of physical devices and software) able to emulate the human capacity of recognizing the letters and the words, giving them a meaning, independent of the graphical style used. Ideally, this activity should be performed in a fast and accurate way, also with very long texts. This kind of activity usually known as Optical Character Recognition (shortly OCR), is of great interest in various industrial contexts. As an example, the United States Postal Service has been using OCR machines since the mid 60s to read names, addresses and postal codes on letters, to speed up delivery processes. Another field of applicability is surely the bank checking process, where a great number of documents (such as cheques) and signatures have to be validated.

The OCR systems are usually divided into two categories; the online OCRs are able to recognize the text as it is written on-the-fly, maybe on a tablet (usually a small handheld computer, also known as personal digital assistant, or PDA), while the offline OCRs read a full text, previously written, and they translate it into an editable one. The handwritten pattern recognition system is still a subject of research; high rates of success in the recognition process are always a problematic issue, especially for Chinese and Arabian characters.

During the last decades, researchers have tried to mix a letter-by-letter recognition strategy, which seems not to be sufficient to achieve high success rates with a dictionary and contextual strategies, which are always used by human beings.

As explained above, the high variability in the graphical styles represents a key issue to deal with for the implementation of an efficient recognition strategy. For this reason, the vast majority of OCR systems are based on “fuzzy logic” algorithms, which can efficiently manage databases containing vaguely defined or in-contrast data.

Extensive research has been conducted in order to design efficient OCRs, and different approaches have been followed, using, for example, the Bayesian theory of decision, artificial neural networks and many other tools coming from the multivariate analysis of data, statistics and signal processes opportunely combined and used (see for example [1] and [2]).

A quite commonly used strategy for the offline character recognition (summarized in Figure 2) firstly needs an image containing the text to be analyzed. Secondly, the words have to be identified in the image file and letters have to be extracted. This phase is usually known as segmentation and it can be performed using many different approaches and strategies. Then, the letters have to be opportunely treated to be subsequently managed by the recognition algorithm: the main objectives are to reduce the noise and to normalize the letter. The OCR has to be learned at first by using a sufficiently large and heterogeneous dataset. This is the crucial phase to get the best performance from the OCR and it is usually known as learning phase. Once the training has been completed, the OCR can be employed to treat automatically new texts which have not been used during the learning phase. This is the classification phase.

It is easy to understand that the preprocessing phase has a fundamental role, both during the learning and running phase of the OCR. Actually, high recognition scores are very often due to sophisticated preprocessing. In this paper, we especially focus on the last two phases, training and classification, showing how some tools provided in modeFRONTIER can be efficiently used to build a simple but efficient letter-by-letter OCR for the Italian alphabet. Finally, a free OCR software (download available in [4]) has been used to have a comparison and to judge the quality of the obtained results.

### The database construction

The database used in this paper has been artificially built using the following approach. Some handwritten fonts have been downloaded (see [3]), and an image of the Italian capital alphabet for all the fonts has been produced. These images, totally 201, could be regarded as the collection of the alphabet written by different persons.

This way of building the database has been chosen among many others for its easiness and for the possibility to generate quickly a sufficiently large number of alphabets. The main drawback is probably a lack of “randomness” in the graphics,

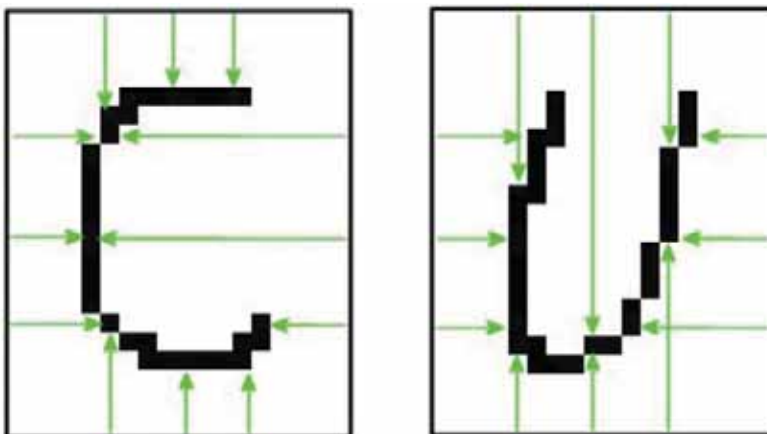


Figure 4: Three probes are used for each letter side to measure the distance between the boundary and the first black pixel in the image. These probes allow to have important information on the shape of the letter, which could be, in some cases, extremely important to correctly identify the letter under exam. For sake of clarity some white bounds around the letters have been left in the picture; the adopted procedure uses the probes on a cropped image which do not have any white space around.

which is typical of a human handwritten text. Obviously, the interested reader can verify the effectiveness of the proposed techniques using other databases, may be constructed on real handwritten alphabets.

A first Matlab script reads the images, extracts the letters and writes them into a new set of 21 images. This procedure could be seen as a sort of simple text segmentation.

A second Matlab script is charged to read the letters, preprocess them and write some key information on a text file; this phase is composed by the following steps:

1. read the image previously extracted from the text,
2. transform the image into a pure black-and-white scale (e.g. the letter image is transformed into a matrix containing 1 where the pixel is on and 0 otherwise),
3. skeletonize the image (reduce the image to its skeleton, to highlight the most important features of the letter),
4. normalize the image (reduce the image to 15 rows for a 10 columns image),
5. probe the image (measure the image's depth at some given points),
6. write a database (write on a text file all the relevant information).

The steps described above allow to extract some key features from a letter image and fix them into a database. The first fundamental step consists in a “binarization” of the image with a consequent reduction of noise; this makes the recognition process less sensitive to the image quality and color. The skeletonization reduces the letter thickness to just one pixel, preserving the continuity of the graph; this operation is fundamental to normalize the letters nullifying the thickness of the graphical sign, which is one of the most important sources of variability. The image downsizing is the last operation, but it is fundamental to treat images which originally can have any dimension and resolution.

Other steps could be introduced with the aim to improve the standardization of the letter; the reduction of insignificant features (such as curls), the reduction of letter inclination and



the closure of gaps in the pen stroke. All these operations certainly help in improving the recognition rate but they require a rather complex implementation; this is out of the scope of this work and therefore, we decided to organize the simplest preprocessing possible while preserving a certain effectiveness and quality in results.

The database contains the matrix describing the normalized image (as explained above) and a vector of 21 components, one for each letter in the alphabet; the *i*-th component of the vector assumes a non zero value if the letter under exam is the *i*-th in the alphabet, 0 otherwise.

Moreover, three probes on each letter side (see Figure 4) are used to measure the distance between the boundary and the first black pixel in the image; this allows to have some information on the shape of the letter in the database.

The obtained database can be loaded in modeFRONTIER following the wizard step by step. The variable names are loaded automatically, simplifying the user work.

**The SOM approach**

As explained above, the database used for the learning phase is made by three different contributions. The first one is given by 15 x 10 (=150) variables which can assume the value 0 or 1 according to the status of the image pixel. In this way, the distance between two “perfectly” identical images, except for a single pixel, is exactly 1. Then, there are 3 x 4 (=12) columns, one for each probe, and they can range between 0 and 50; the value given by the probe as the distance between the image boundary and the first black pixel is multiplied by 50 and then divided by 10 or 15 according to the direction of the probe (horizontal in the first case, vertical in the second). This means that a difference in a probe is 50 times more important, as a maximum, than a change in a single pixel. The last contribution in the database is given by 21 columns, one for each alphabet letter, which can assume the value 50 or 0 if the letter under exam corresponds, or does not, to the one to which the column refers to. This allows a unique identification of letters in the database and it is fundamental during the learning phase.

It is obvious that this last contribution does not appear in the dataset that will be used to test the OCR, which should be able to give us evidence of the letter we are looking at.

The different weights are fundamental to obtain an efficient OCR and they have to be chosen with some attention.

Once the construction of the dataset has been concluded, a self organizing map (SOM) can be easily built following the wizard step by step. Obviously, no scaling has to be done of database values in order to not nullify the effect of the weights described above.

In Table 1, the set up used for the construction of the sequential SOM applied to this work is collected. Other choices are possible but, if “reasonable” values are chosen, the final result is not influenced too much. Once the SOM training has

Initialization	Training parameters	Phases parameters
X units 20	Learning factor 0.5	Initial rough radius 2
Y units 20	Neighbor function Gaussian	Final rough radius 1
Initialization Linear using PCA	Learning function Linear	Rough phase length 15
Random seed 1	Sample choice order Random	Initial fine tuning radius 1
	Random seed 1	Final fine tuning radius 1
		Final fine phase length 5

Table 1: the sequential SOM set up used in this work

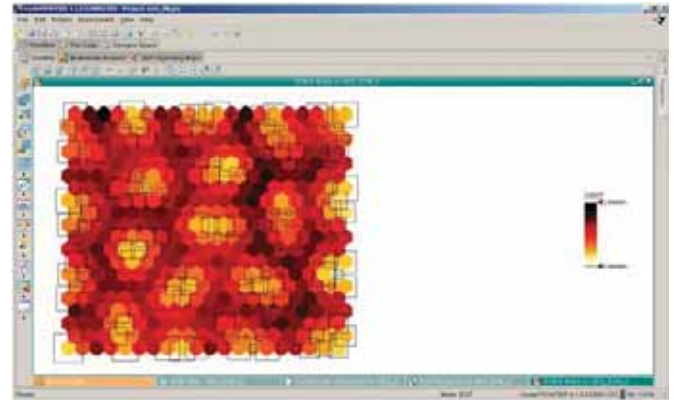


Figure 5: In the D-matrix the mean distance between neurons in the map is plotted. In this case 21 groups of data corresponding to the letters are clearly visible. The square sides are proportional to the number of designs (letters) that have been “captured” by the neuron.



Figure 6: The database components pertaining to the letters have been all plotted on the net using different colors. The clusterization of data, as shown in Figure 5, is here highlighted with some white circles.

been completed, it is possible to look at the D-matrix, as shown in Figure 5. It is clear that a clusterization of data is present, as expected and wanted, and it is primarily due to the weights adopted for the dataset components. If a new SOM with range scaling of data were built, this clusterization would disappear. The sides of squares superimposed to the D-matrix graph are proportional to the number of designs that have been captured by the neuron during the learning phase.

In Figure 6, the organization of the designs in 21 groups is made more evident by means of colors and white circles which delimit the area of each letter. It is interesting to note that some letters which look similar (such as E and F or C and O) fall very distant in the SOM; this means that the probes are effective and the difference between, even small in some cases, is captured. The same cannot be said for letters U and V which fall very close to one another: the probes cannot efficiently register the difference between these two letters and this could be a possible reason for a recognition failure.

**The letter recognition**

In this section, we present the results obtained using a free OCR software (freeOCR, see [3]) and the SOM, as built before,



Figure 7: Some letters for whom the recognition process fails.

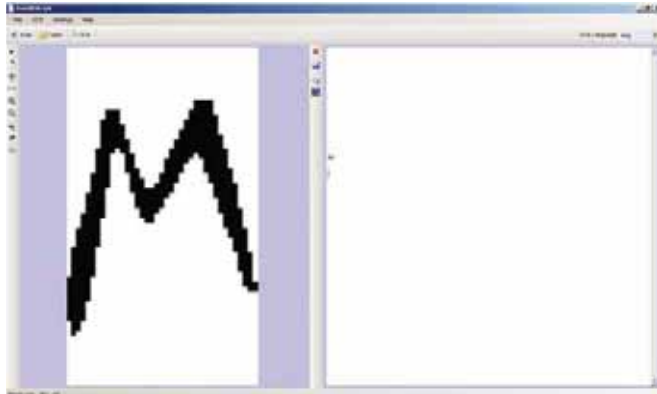


Figure 8: The freeOCR software used to test the effectiveness of the OCR system implementer in modeFRONTIER. Specifically, a letter M is tested on the left and the software correctly recognizes it on the right.

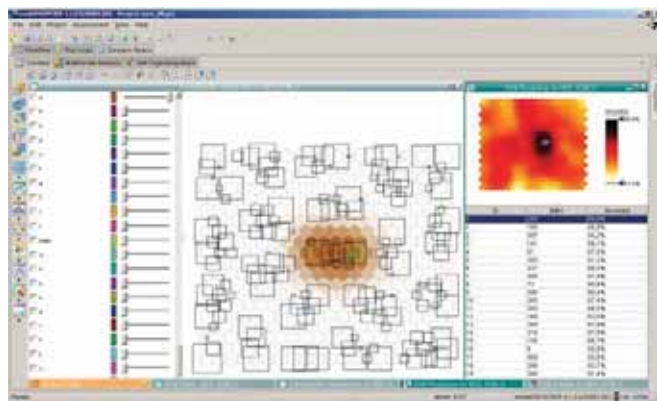


Figure 9: The SOM can be used as a predictive tool; in this case an incomplete dataset has been loaded (TEST 1) and the SOM is asked to guess the letter corresponding to a given row in the dataset. In the picture the first record of dataset corresponds to an A; the BMU (right) falls in the zone of the net corresponding to the letter A (left).

applied as a predictive tool. Two different alphabets (TEST 1 and TEST 2 are shown in Figure 10) not used for the SOM learning have been adopted to build two incomplete datasets; the third ingredient, corresponding to 21 columns ranging from 0 to 50 as described above, actually has not been included.

In Table 2 a, a comparison between the results obtained with these two approaches is reported. When the recognition fails, the letter(s) proposed by the algorithms is (are) reported. We can say that the two approaches both present difficulties in the recognition of some letters, although the given answers cannot be considered as a complete failure. For example, if the Q of TEST 1 is considered, as shown in Figure XX, it can be immediately seen that there is a certain affinity with a G and that it could be divided into two letters, a C and a smaller L. On the contrary, the freeOCR fails to recognize the F of TEST 1, while the V of TEST 2 is not recognized as a letter but rather as two characters (\) which however look like a V.

Letters of TEST 1	SOM	FreeOCR	Letters of TEST 2	SOM	FreeOCR
A	OK	OK	A	OK	OK
B	NO (D)	OK	B	OK	OK
C	OK	NO	C	OK	OK
D	NO (O)	OK	D	OK	OK
E	OK	NO (I)	E	OK	OK
F	OK	NO (V)	F	NO (P - F)	OK
G	OK	OK	G	NO (S)	NO (ET)
H	NO (U)	NO (I)	H	NO (U - M)	OK
I	OK	OK	I	NO (S)	OK
L	NO (U - L)	OK	L	OK	OK
M	OK	OK	M	OK	OK
N	NO (M - N)	OK	N	OK	OK
O	OK	OK	O	OK	OK
P	OK	OK	P	OK	OK
Q	NO (G - Q)	NO (CL)	Q	OK	NO (G)
R	NO (D)	NO (T)	R	OK	OK
S	OK	OK	S	OK	NO (E)
T	OK	OK	T	OK	OK
U	OK	OK	U	OK	OK
V	OK	NO (-)	V	NO (U)	NO (I)
Z	NO (L)	NO (I)	Z	NO (I)	OK

Table 2: A comparison between the results obtained with the SOM approach proposed in this work and the ones obtained with the freeOCR software. For the TEST 1 an alphabet not used during the learning phase has been adopted, while for the TEST 2 a real handwritten alphabet has been used. When the recognition fails, it is reported between brackets the letter which are proposed by the algorithm.



Figure 10: TEST1 and TEST2 alphabets used to test the character recognition based on the SOM.

**Conclusions**

In this paper we have shown how some tools of modeFRONTIER can be used to build a simple but efficient letter-by-letter OCR system. This naïve system has been compared to a free software downloadable from the internet and the results are undoubtedly good.

As mentioned, a high rate of recognition success can be reached only with a sophisticated preprocessing phase of text; this goes beyond the scope of this work and therefore, the interested reader is addressed to the following literature for more details.

**References**

- [1] Gosselin Bernard (1995), Application de reseaux de neurones artificiels a la reconnaissance automatique de caracteres manuscrits, Ph.D. thesis, Faculté Polytechnique de Mons
- [2] Vuori Vuokko (2002), Adaptive methods for on-line recognition of isolated hand-written characters, Acta Polytechnica Scandinavica, Mathematics and Computing Series No. 119, Espoo 2002, 93 pp.
- [3] The freeOCR software has been downloaded from <http://softi.co.uk/freeocr.htm>
- [4] The handwritten fonts used in this work for the training phase have been downloaded from <http://www.1001free-fonts.com/handwriting-fonts.php>

For more information about this article, please contact the author: Ing. Massimiliano Margonari - EnginSoft S.p.A. [info@enginsoft.it](mailto:info@enginsoft.it)

# A modeFRONTIER Application: Data Mining the Italian Municipalities

Nowadays we are frequently bombarded with large quantities of data describing aspects of our world or work in great detail. A very common problem is that there is simply too much data for us to interpret sensible meaning or patterns. A new discipline, data mining, is rapidly developing to describe the process of extracting meaningful patterns from these complex data sets. The purpose of this paper is to show that modeFRONTIER can be considered as a powerful data mining tool, well-equipped to perform the widest possible range of important data mining tasks.

What makes good data mining software? The most basic requirement is easy access to the data. This implies a wide range of flexible import facilities from a variety of formats. Once the data is accessible, it will be important to have flexible and adaptable analytical techniques, including powerful numerical methods. A rich repertoire of charts and tables will certainly be necessary for visualizing the results, and good mechanisms for exporting these conclusions to other software for presentation and documentation.

This paper will illustrate how modeFRONTIER meets all these requirements. Through a comprehensive example, it will show how modeFRONTIER offers a delicious recipe based on the mixing of these important ingredients.

## Database description

The database presented in this article comprises the most relevant characteristics of all Italian municipalities in terms of population, latitude, longitude, age, average income etc. This database was created by extracting the data from the website "http://www.comuni-italiani.it/"

In fact, the database was established using an automatic mining system that identifies and extracts regularly structured data from web pages. The database collects all the Italian municipalities with each row containing 12 specific elements:

- The name of the municipality
- A unique identification number for the municipality
- The total surface area of the municipality in square kilometres
- The latitude and the longitude of the town hall in decimal degrees
- The elevation in meters above mean sea level of the town hall

- The total number of residents in 2005 (males and females)
- The density defined as the ratio between the total population and the surface area
- The population ageing index as the ratio between residents older than 65 and residents younger than 14
- The total number of households
- The average incomes (in Euros) declared in 2005 by the people living in the municipality
- The total number of houses

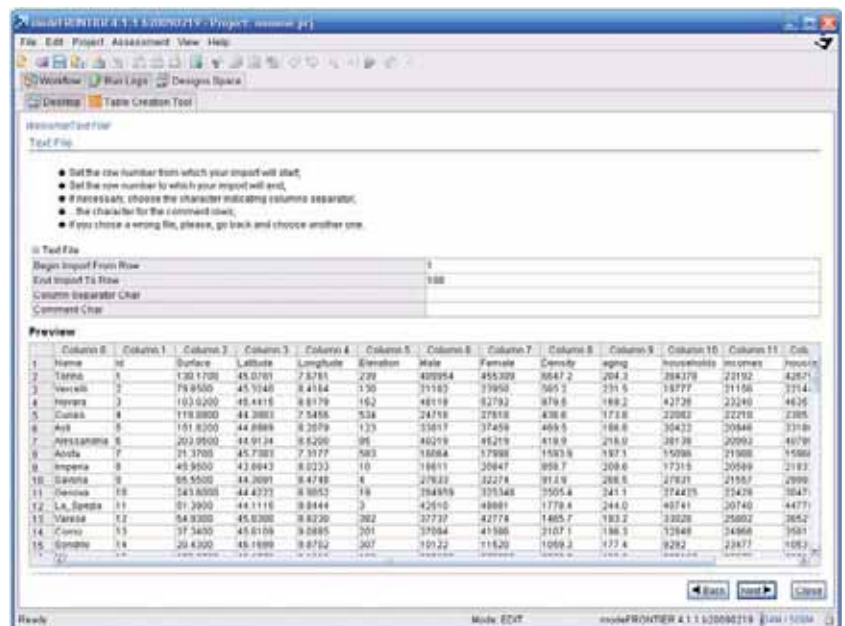


Figure 1: one step of the Data Wizard. The tool for importing data into modeFRONTIER

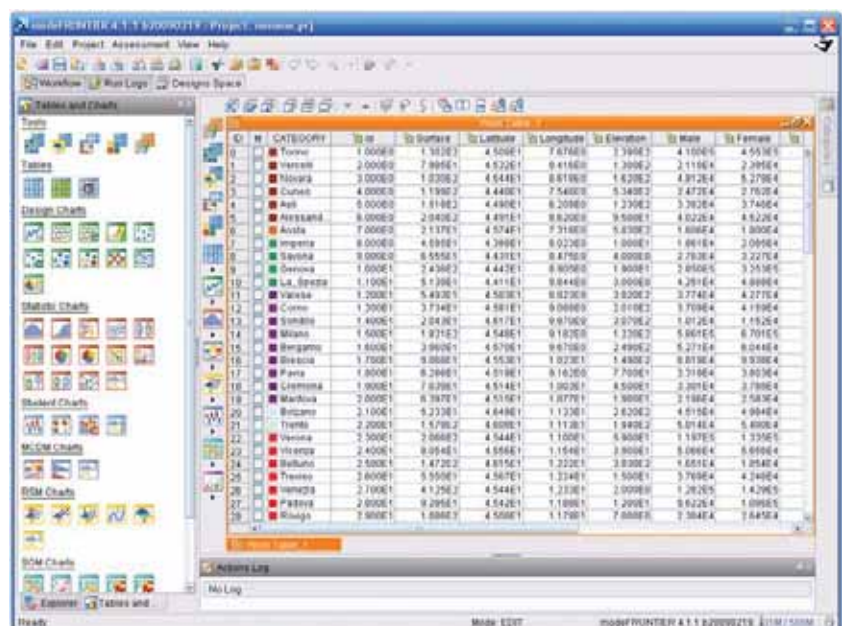


Figure 2: The database view as it appears in modeFRONTIER

- The heating degree day (HDD) that is a quantitative index that reflects the demand for energy to heat a home or business. HDD is reported in [KD/a], Kelvin days per year.

Obviously, the database could be much larger, but to focus on this example, we limit our table to the mentioned data. We will learn that we can extract interesting deductions, even by analyzing this reduced data set.

The first step for data mining is to input raw data in a very convenient way. In modeFRONTIER, the loading and filtering of data is really easy. This can be done from formatted files, EXCEL tables or from relational databases, such as, for example MySQL and Oracle. During the import phase, the user may remove rows and columns containing useless data, specify the role of each column, insert objectives and constraints if any, and set up the visualization format for numbers. Moreover, thanks to modeFRONTIER's worktable capabilities, it is also possible to insert additional columns containing derived data. Once the data is well organized in a table, the data mining software should help the users in identifying important patterns that are not visible at first glance due to the quantity of data and/or the high dimensionality of the problem.

Furthermore, and thanks again to the worktable capabilities, it is also possible to insert additional columns containing derived data. In this example, we can introduce the average number of people per household in Italy. This value can be derived quite easily by introducing the transfer variable  $\text{averageHousehold} = (\text{male} + \text{female}) / \text{households}$  as reported in Figure 3. When a derived column is introduced, it is possible to make queries according to this new information. For example, in

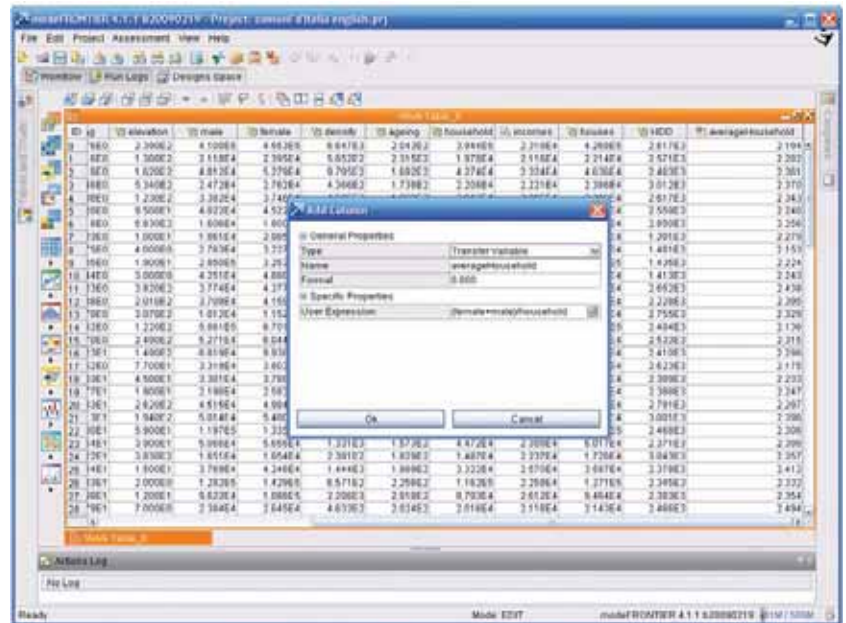


Figure 3: Derived data may be easily introduced in the database view

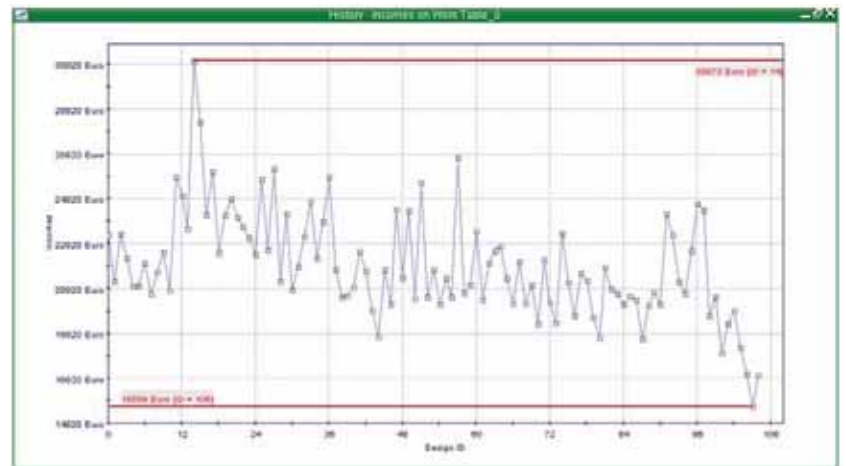


Figure 4: Pointing out the gap between highest and lowest earners in the big cities

this case, it is now very easy to determine the Italian cities with the highest and lowest household size, these turn out to be Foggia and Trieste respectively.

### Analyzing the data

We can start analyzing the database in modeFRONTIER with the help of available charts beginning with the simplest chart, the history plot. Figure 4 reports the history plot of the average incomes of all Italian cities, the red lines point out the income gaps between the highest (Milano with 30,973 Euros) and lowest (Sanluri with 15,589 Euros) earners in Italy. Similarly, we can even plot a multi-history chart,

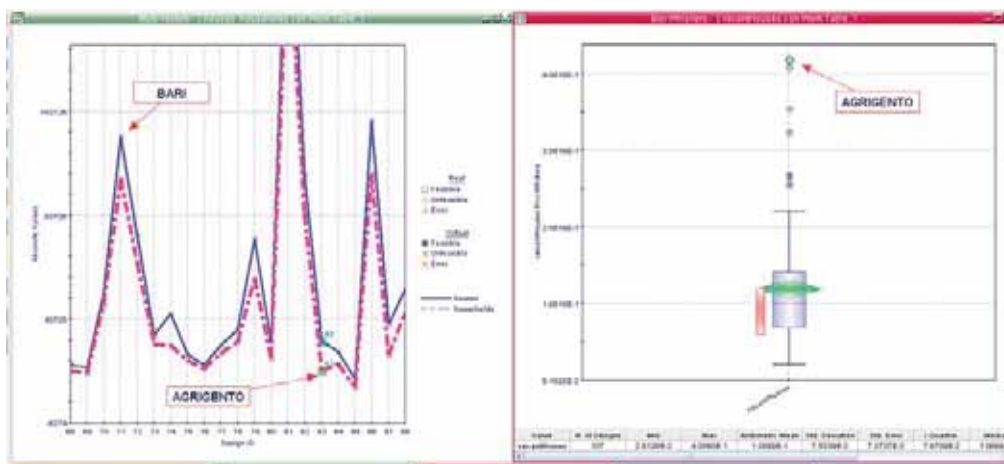


Figure 5: on the left a multi-history chart with houses and households, on the right the distribution of the vacant houses in Italy represented with a box-whiskers plot.

putting in the same plot for the number of houses and the number of households. Now, we may ask how many houses are occupied and how many are vacant or second homes (for example holiday accommodation).

To answer to this question, we introduce an additional column that counts the number of vacant houses with respect to the total number of houses in the territory.  

$$\text{vacantHouses} = (\text{houses} - \text{households}) / \text{houses}$$

Figure 5 shows on the left a multi-history chart with houses and households, and on the right, the distribution of the vacant houses in Italy represented with a box-whiskers plot. The multi-history chart shows that there is a strong relationship between the number of houses and the number of families in the territory, pointing out that Roma is the most populated city. The box-whiskers plot can be used to visualize the distribution of data in an effective way, summarizing some information of the data, such as the mean and its confidence interval, the quartiles and outliers. These last ones are the designs which fall out of an interval

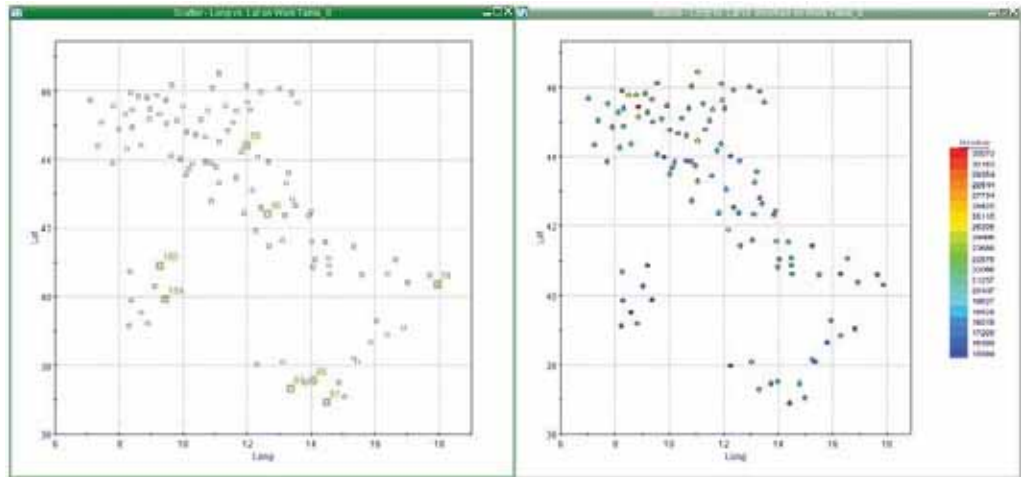


Figure 6: on the left a 2D scatter chart with highlight on the cities with many vacant houses, on the right a bubble chart with the color given by the outcomes.

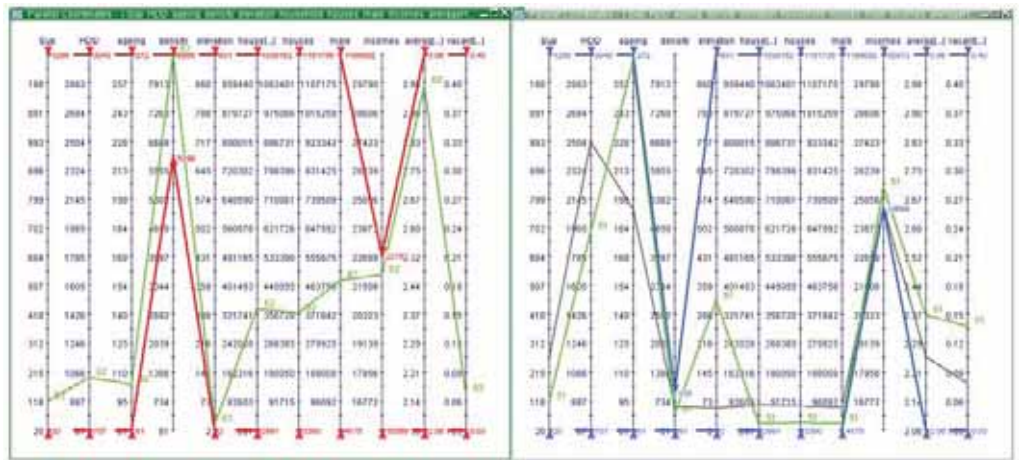


Figure 7: creating filters on the data. On the left, the red filters are looking for cities with high density and low incomes. On the right, the opposite situation is created, with a filter for selecting cities with high incomes and low density.

centered in the mean and with semi-amplitude of 1.5 the standard deviation. Our box-whiskers chart shows up the situation of Agrigento, a city with 43% of vacant houses - a real outlier.

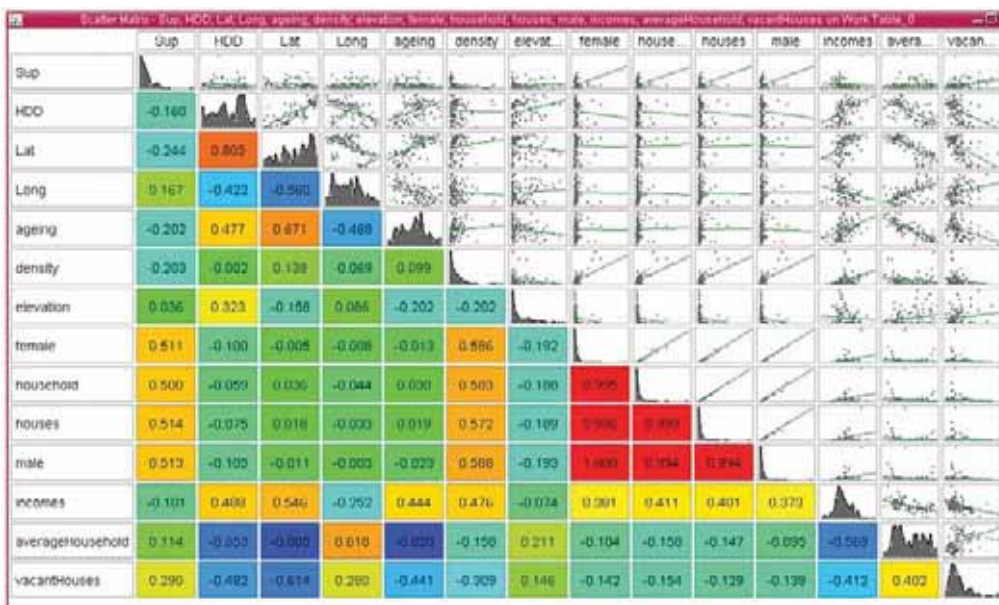


Figure 8: scatter matrix of the data, this chart summarizes in a single chart the correlation chart, all the 2d scatter charts with the regression line.

How can we identify easily all the other cities with many vacant houses and check where these cities are located? This is accomplished by clicking on all the outlier points in the box-whiskers chart and plotting a 2-D scatter chart using the longitude and the latitude. In Figure 6 (left), we can see that the cities with the higher number of vacant houses are located near the coasts, and this is probably justified by the higher proportion of holiday homes in those areas. Figure 6 (right) represents a bubble chart with the color of

the bubbles indicating the value of the incomes. The bubbles provide a way for displaying a third variable in a two dimensional chart. The bubble chart shows, at a first glance, that there are income gaps between the average values of the North and the values of the South of Italy. By means of the parallel coordinate chart, it is possible to create filters on the data.

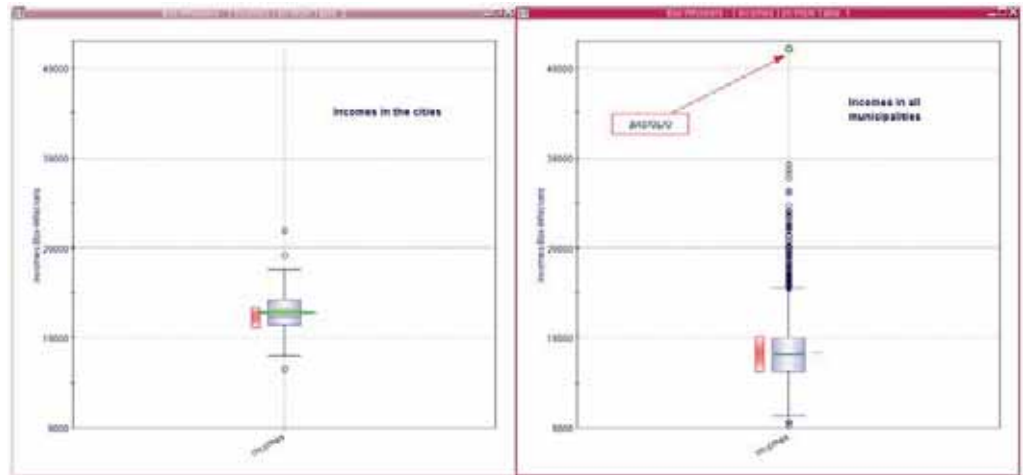


Figure 9: Two box-whiskers plots comparing the incomes between big cities and countryside.

Figure 7 shows two examples of filters created on the database view. The filter on the left is looking for cities with high density and low incomes; the selected line represents the city of Napoli. In the other chart (on the right), the opposite situation is created, the blue lines create a filter for selecting cities with high incomes and low density. The two lines surviving the filter are Parma and Siena. This means that Parma and Siena share the common characteristics of wealth and spaciousness.

The correlation matrix and the scatter matrix are other useful tools available in modeFRONTIER, to check if there is any relation between the data. The correlation coefficient is a measure of the closeness of the linear relationship between two variables. The correlation coefficient is a pure number which

can range from -1.00 to +1.00, a value of -1.00 represents a perfect negative correlation while a value of +1.00 represents a perfect positive correlation. Positive values of the correlation indicate a tendency of the two variables to increase together. On the contrary, when the coefficient is negative, large values of the first variable are associated with small values of the second one. In the scatter matrix, the scatter plots together with the regression lines help to visualize the data and understand how they are distributed in the space. All the graphs can be enlarged, printed and explored.

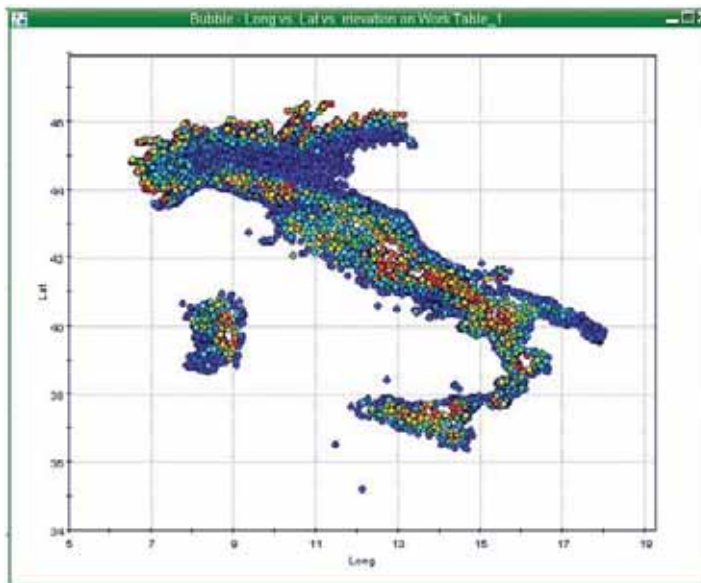


Figure 10: A very nice view of Italy, a bubble chart with longitude, latitude and elevation

In this example (Figure 8), it can be seen that the most important negative correlations involve the ageing and the average household size (-0.820). This can be explained by the fact that when the age of the population increases, it is more common to find single person households, widow and widower for example. Apart from some expected relation between number of people and houses, one of the most important positive relations involves the heating degree day (HDD) and the latitude (0.805): this means, that the heating requirements in the northern parts of Italy are much higher than in the South.

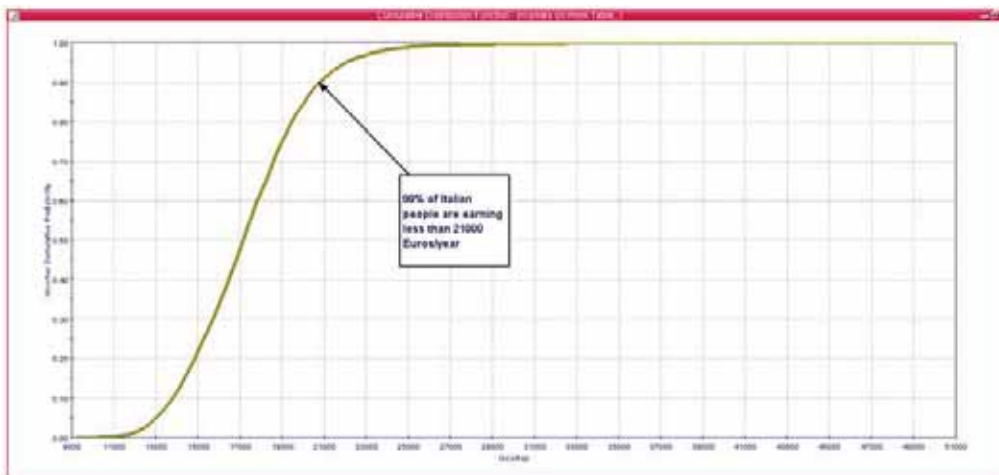


Figure 11: The cumulative distribution function chart showing that only 10% of Italian population declares more than 21,000 Euros per year.



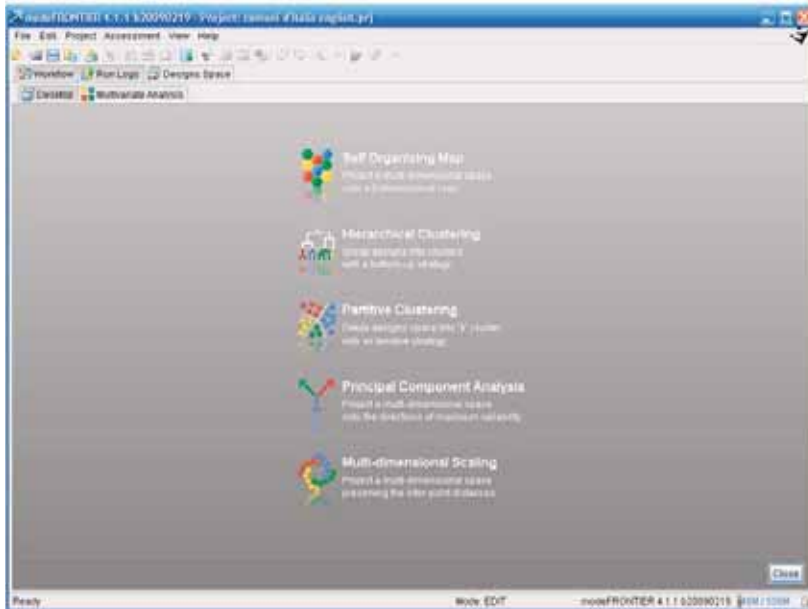


Figure 12: Multivariate analysis panel: from here the user can access all the data analysis tools available in modeFRONTIER

So far, the charts have been created only taking into account the biggest cities and not all the Italian municipalities. Now, we are going to import the complete list of Italian municipalities (more than 8,000) and compare the values between municipalities and big cities.

For example, it is very interesting to compare the incomes between big cities and rural areas. This is possible in modeFRONTIER because we can maintain more than one view in the same project and compare and combine the tables. Figure 9 shows the difference of the distributions of incomes in the big cities with respect to the incomes in all Italian municipalities. Apart from Basiglio where people are so rich that can be considered “out of the range”, the average incomes in the cities are usually much higher than the average household incomes in the countryside. To be precise, the average income in the cities is 21,833 and 17,320 across all Italian municipalities, a difference of more than 4,000 Euros per year.

When we use some statistical charts to evaluate the incomes, we discover that 90% of Italian people are earning less than 21,000 Euros per year.

### Multivariate Analysis

Multivariate Data Analysis (MVA) refers to any statistical technique used to analyze data that arises from more than one variable. Traditional tools allow only a partial representation of a multivariate database, hence the user may not have a global view of the dataset and therefore, data mining could be extremely difficult and unfruitful.

MVA can be used to:

1. Summarize complex data tables.
2. Analyze groups in data, to inspect how these groups differ and to assign each instance to a group.
3. Find relationships between the variables and how some variables can characterize different groups.

modeFRONTIER has a multivariate analysis environment which contains the following tools: principal component analysis (PCA), multi-dimensional scaling (MDS), self organizing maps (SOM), partitive clustering (K-means), and hierarchical clustering. When available information is stored in huge tables containing rows and several columns, this environment (see Figure 12) can be used to process the information in a meaningful fashion.

### Multidimensional scaling

We can now start using this multivariate analysis tool to analyze the data of the Italian municipalities using, for example, the multi-dimensional scaling (MDS) tool. The goal of MDS (Cox 94, Borg, 97) is to produce a low-dimensional representation of multivariate samples such that distances between the points in the lower dimensional space best match those in the original space. This way, a one-to-one correspondence between data and projections is achieved, usually in a 2-dimensional space.

In this example, we can try to project in a 2-dimensional space, the 3-dimensional problem of the Italian cities with their longitude, latitude and incomes. If you run a MDS on the data, for each city, a corresponding location in the 2-dimensional chart is determined in order to preserve as much as possible the interpoint distances of the data. What happens to our data is really interesting. Figure 13 shows the difference between a longitude-latitude plot of Italy and a

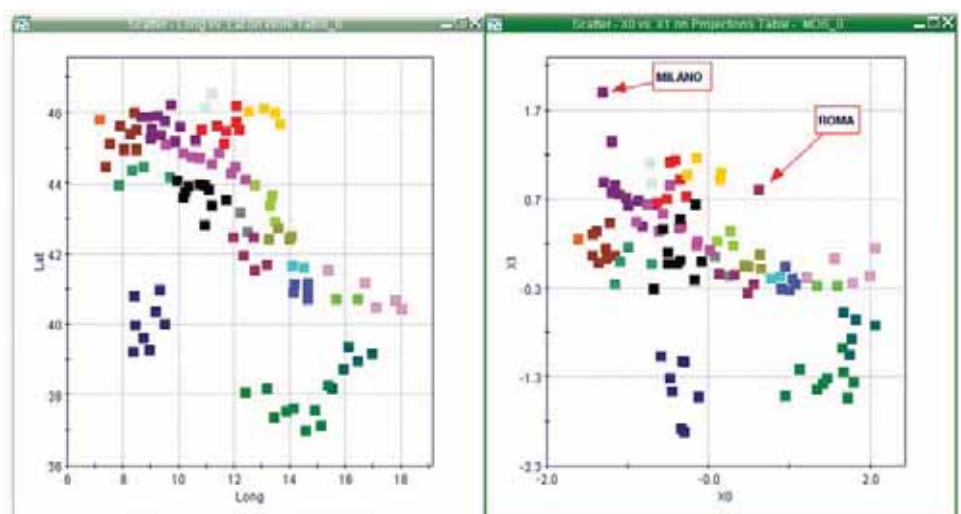


Figure 13: On the left a scatter plot of the longitude and latitude on Italian cities with colors given by the different regions. On the right, the scatter plot represents a projection of the cities given the incomes as a third dimension.

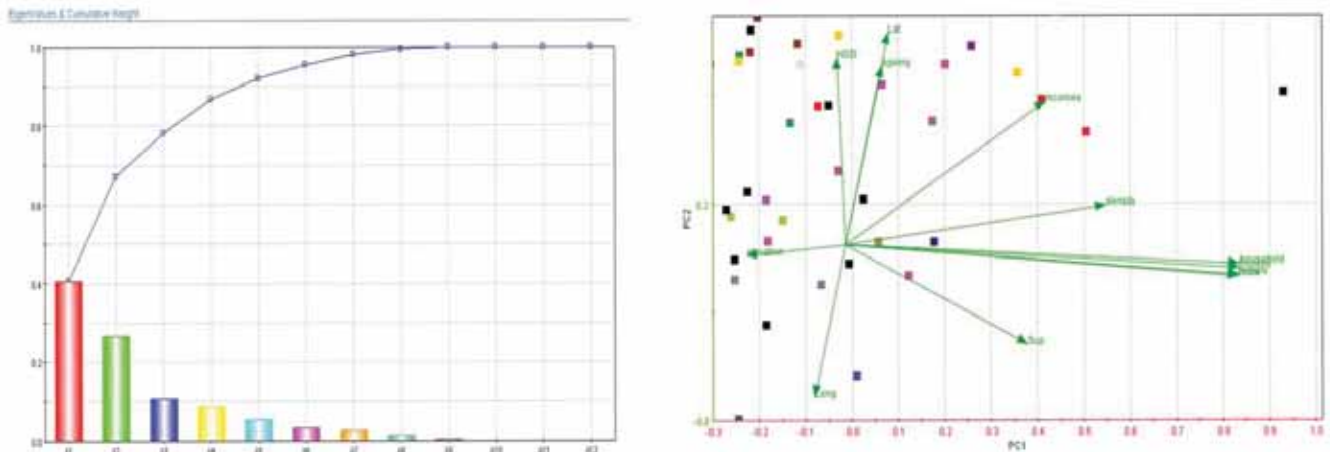


Figure 14: On the left, eigenvalues and cumulative weight of the PCA on the municipalities database. On the right, the projections and the contribution of the original variables

projection of Italy according to the incomes. The colors in the chart are given by the regions and are very helpful in verifying that the structure of the country and its regions are more or less maintained in the projection, we may say that the incomes are quite uniform within the regions. It is interesting to note that the Northern part of Italy is a bit stretched in the MDS projection due to the positive economic situation of Lombardia, which is represented by purple points. In the MDS chart, it can be even noted that the only city which is moving away from all the other cities of its region is Roma. This testifies to the fact that Roma is a rich city in the middle of a less favorable region.

### Principal Component Analysis

Principal component analysis (PCA) is a method which finds projections of maximal variability. This means that it searches for linear combinations of the data. It can be used for multidimensional data visualization and for multivariate correlation analysis.

If we run a PCA on the Italian municipalities database, we discover that we could potentially restrict our database into five dimensions preserving more than 90% (see Figure 14) of the information coming from the data: all the other dimensions may be considered linear recombinations of these former dimensions. The projection indicates that there are several variables sharing a similar trend (e.g. male, female, density, households) and that some of them may be neglected for further inspections.

### Clustering

The aim of clustering is to find patterns in data. A cluster is a subgroup of data which are "similar" between each other and are "dissimilar" to those belonging to other clusters. Generally, the

similarity criterion is given by the Euclidean distance but many other measures can be considered. Clustering methods can be divided into two types: hierarchical and partitional clustering (K-means).

In this section, we will perform the hierarchical clustering of the Italian municipalities, although we should note that other interesting results could have been obtained by the application of different methods.

Hierarchical clustering proceeds by iteratively merging smaller clusters into larger ones. The result of a hierarchical clustering algorithm is a tree of clusters called dendrogram, which shows - from a tree view - how the clusters are related. By cutting the dendrogram at the desired level, a clustering of the data into disjoint groups is obtained. For example, in our case trying to create a hierarchical clustering on all the data excluding the latitude, the longitude and the identifier to avoid any bias on the results, we obtain the dendrogram in Figure 15 where a subdivision of the cities into three different groups is proposed.

If we apply the proposed clustering to the data, we can plot the chart in Figure 15 (right) and we can, once more, verify that even if the latitude and the longitude are not taken into account, all the other values (the households, incomes, HDD, inhabitants, ...) can be sufficient to recognize some "dissimilarities" between the North, Center and South of Italy.

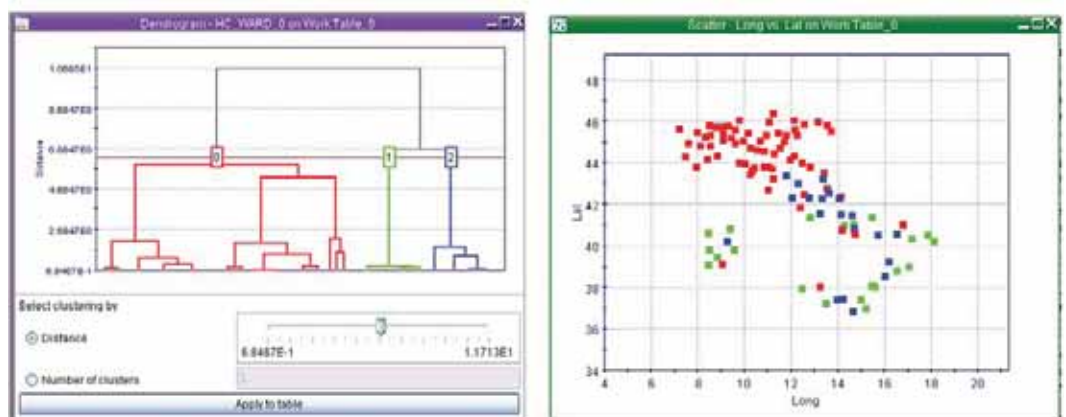


Figure 15: On the left, a dendrogram of the database, 3 clusters are proposed as a good clustering. On the right the clustered Italy



### Curiosities

Without creating any charts we can discover some of the extremes in Italy by selecting the maximum and minimum of the columns of cities and municipalities. For example, we can easily see that the most elevated town of Italy is Sestriere (in the province of Torino), the highest city is Enna (931 m), and the lowest city is not surprisingly Venezia (2 m), while Taglio di Po, Comacchio and Lagosanto are at sea level. We have the highest density of population in Portici (in the province of Napoli) and the lowest density in Briga Alta (in the province of Cuneo); the highest incomes are in Basiglio and in Milano as a big city, and the lowest incomes are in Maniace (Catania) and Sanluri. Otranto (Lecce) citizens are the first Italians to greet the rising sun, since the town has the highest longitude, while Bardonecchia (Torino) is the most western place of the country.

### Conclusions

In this article, the authors drew a range of conclusions starting from a database of numbers; this means that authors transformed data into knowledge. There is a tendency among many people to refuse to believe these types of statistical studies, particularly when the results of the studies do not respond to their previous beliefs. It is well known folklore that statisticians have the ability to obtain any result that they wish simply by massaging the data.

In truth this is not correct. The real issue is that data can be examined with an infinite range of techniques. The careful selection of an appropriate technique crucially depends on the question that we are trying to answer. For instance, in our database of Italian municipalities, we concentrated more on the incomes than on the other characteristics.

The same multivariate analyses tools applied to other data, such as the aging of the households, could have delivered completely different information. Thus we should emphasise that these pages do not represent a basis for a complete description of Italian economics, Italian habits or happiness. The aim of this article is simply to show typical instruments that can be used for data mining and to demonstrate how this can be easily achieved with modeFRONTIER.

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# Growing demand for modeFRONTIER in DACH countries

EnginSoft GmbH sees a growing demand for the modeFRONTIER environment, in particular among the power generation, pump manufacturing, electronics and sensor industries in Switzerland and Germany. In fact, new users in industry and research are applying the software to product

## R&D benefits from Multi-objective Optimization

design and development, for example to handle complex data and solutions, to optimize processes such as transmissions and to meet overall customer requirements. The use of modeFRONTIER speeds up product development and provides considerable savings in time and costs.

This trend was also witnessed recently at the 7th European LS-DYNA User Conference on 14th & 15th May, where EnginSoft GmbH presented a paper on "Optimization and Robustness of Complex Material Model Simulations with modeFRONTIER". The conference attracted 330 attendees to Salzburg Congress on the two days of the event.

The Speaker and German team later welcomed delegates at the EnginSoft booth in the exhibition where discussions included the use of optimization techniques for crash and impact simulations and material characterization, topics that are of continued interest to LS-DYNA users.

EnginSoft GmbH based in Frankfurt/Main not only markets the modeFRONTIER software, the German office also offers tailored training and a dedicated seminar program which includes regular Webinars for those who cannot travel but wish to be up-to-date with the latest enhancements and features of the technology.

Moreover, the Frankfurt team of engineers, consultants and software experts provides CAE consultancy services and innovative solutions for product development to EnginSoft customers in the German-speaking market.

For more information and to contact EnginSoft Germany, please email to: Sybille Arthen - [info@enginsoft.com](mailto:info@enginsoft.com) [www.enginsoft-de.com](http://www.enginsoft-de.com)



## EnginSoft France presents Flowmaster V7 Aerospace and modeFRONTIER V4.I to the Aerospace Industries

modeFRONTIER is a multi-objective design optimization software produced by ESTECO EnginSoft Tecnologie per l'Ottimizzazione srl Trieste - Italy, widely and increasingly used in the aerospace industries as an efficient, state-of-the-art optimizer. modeFRONTIER allows easy coupling to virtually any CAE package available today, and in particular to the CFD commercial codes commonly applied in the aerospace and defense fields. Among the key features of modeFRONTIER are statistical analysis and data mining tools,

**EnginSoft France is pleased to showcase its flagship products modeFRONTIER™ V4.I and Flowmaster™ V7, and in particular Flowmaster V7 Aerospace, in Hall 4 (stand D77) at this year's International Paris Air Show in Le Bourget.**

wizards for the creation of meta-models, and special tools to enhance the navigation between different programs and many more.

In fact, modeFRONTIER v4.1 also provides the new Flowmaster v7 Direct Integration node which allows Flowmaster users around the world to exploit the most complete optimization design environment software available on the market.

The Flowmaster Group with its Headquarters in the United Kingdom has over 20 years experience providing industry leading fluid systems simulation software to the aerospace and other industrial sectors.

Flowmaster V7 Aerospace helps design engineers to efficiently design and simulate aircraft fluid systems.

Flowmaster's industry tailored modelling tools, advanced security and team collaboration tools enable key aerospace organisations worldwide to evaluate system designs earlier and to reduce development costs, optimize performances and track system design changes throughout development processes and lifecycles of aircrafts. EnginSoft started business operations in France in 2006 to market modeFRONTIER and support its

## EnginSoft France vous présente Flowmaster V7 Aerospace et modeFRONTIER au Centenaire du Salon International de l'Aéronautique et de l'Espace.

modeFRONTIER est un logiciel d'optimisation de conception multi objectif et multi disciplinaire développé par ESTECO, basé à Trieste en Italie. La simplicité d'ingrétation de l'ensemble des outils CAE et particulièrement des codes CFD font de modeFRONTIER un outil incontournable dans le secteur aéronautique. Ses

**La société EnginSoft France est heureuse de vous annoncer sa participation au 48ième Salon International de l'Aéronautique et de l'Espace, qui se déroulera à Paris, Le Bourget. A cette occasion vous pourrez découvrir deux de ses principaux logiciels, Flowmaster V7 Aerospace et modeFRONTIER V4.I sur le stand n° 4CD77 Hall 4.**

principaux atouts, l'analyse statistique, le data mining, les outils d'aide à la décision, l'optimisation et la simplicité d'interfaçage améliorent considérablement les performances de conception.

modeFRONTIER V4.1 inclus un nœud d'intégration directe de Flowmaster V7, qui permet aux utilisateurs Flowmaster du monde entier de pouvoir exploiter la puissance du logiciel d'optimisation le plus complet du marché.

Le groupe Flowmaster dont le siège social est situé au Royaume Uni, possède plus de vingt ans d'expérience dans la simulation des réseaux hydrauliques pour



Photo: Paris Air Show



users in the French-speaking market. Since February 2009 – under the new partnership agreement signed with Flowmaster France - EnginSoft France is also responsible for the sales, distribution and support of the Flowmaster software products in Southern Europe: France, Italy, Spain.

“The International Paris Air Show will see EnginSoft France showcasing modeFRONTIER and Flowmaster, two best-in-class simulation software products, tailored for aerospace experts”, emphasized Marie Christine Oghly, President of EnginSoft France.

“Since the consolidation of EnginSoft France and Flowmaster France, our customers benefit from a diverse portfolio of software, expertise from our team which has doubled in size,

l’aéronautique mais également dans d’autres secteurs. Flowmaster V7 Aerospace permet de dimensionner efficacement les composants, évaluer plus rapidement la conception des systèmes, et ainsi réduire les coûts et les délais tout en garantissant fiabilité et sécurité.

EnginSoft France a débuté ses activités en janvier 2006 avec la distribution du logiciel modeFRONTIER.

En janvier 2009, un accord de partenariat signé entre Flowmaster France et EnginSoft France confère à EnginSoft France l’exclusivité des ventes, du support et du service en Europe du Sud et la Suisse francophone.

Depuis la consolidation entre EnginSoft France et Flowmaster France, nos clients bénéficient d’un

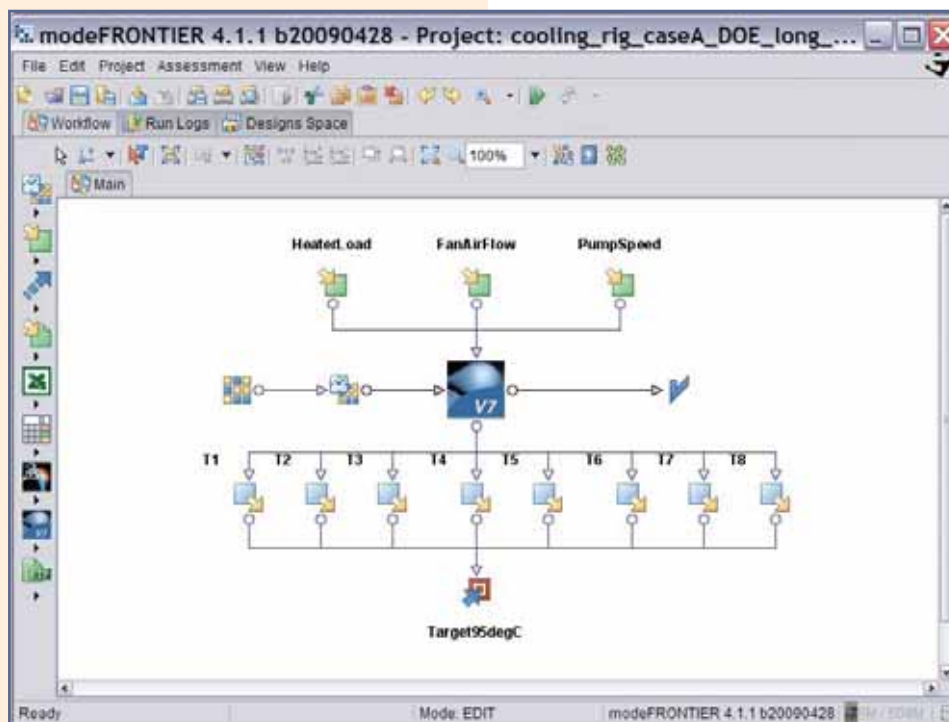


and a variety of consultancy services offered through the EnginSoft Headquarters in Trento-Italy. In fact, and in addition to Flowmaster’s broad experiences and strong position in the aerospace sector, EnginSoft traditionally supports some of the key suppliers in the field with a variety of consultancy services ranging from fluid-dynamic to structural and process simulation. We are truly eager to present our complete solutions and services to the aerospace industries in Le Bourget!”

For more information, please contact:  
Marie Christine Oghly, President EnginSoft France  
info@enginsoft.com

portefeuille de logiciels variés, de l’expertise de notre équipe qui a plus que doublé en taille ainsi qu’un ensemble de services et de conseils par l’intermédiaire de notre Siège à Trento en Italie. La synergie entre Flowmaster et EnginSoft France ne fait que renforcer notre position sur le secteur de l’aéronautique. Elle élargit par la même occasion l’ensemble de ses services allant du calcul fluide à la simulation des processus de fabrication.

“Le Salon International de l’Aéronautique et de l’Espace sera l’occasion de vous présenter modeFRONTIER et Flowmaster, deux des meilleurs logiciels dans leur catégorie” à souligné Marie-Christine Oghly, Président d’EnginSoft France.



# EnginSoft Europe - Event Calendar

## ITALY

1-2 October – EnginSoft International Conference 2009 & ANSYS Italian Conference 2009. CAE Technologies for Industry. Centro Congressi Giovanni XXIII, Bergamo. Discuss with Experts from around the world: How Virtual Prototyping can speed up product development delivering ROI in many forms – in just days! [www.caeconference.com](http://www.caeconference.com)

9-10 June - modeFRONTIER Training Course for Academic Specialists. Università del Salento. For more information, please contact Rita Podzuna, [r.podzuna@enginsoft.it](mailto:r.podzuna@enginsoft.it)

September–November 2009. EnginSoft CAE Academy. 2nd CAE Intensive Training Course. [www.enginsoft.com/academy](http://www.enginsoft.com/academy)

## FRANCE

EnginSoft France 2009 Journées porte ouverte. Dans nos locaux à Paris et dans d'autres villes de France et de Belgique, en collaboration avec nos partenaires, TASS TNO Automotive France, CETIM et autres... Prochaine événement: Journées de présentation modeFRONTIER 4.1 Veuillez contacter Jocelyn Lanusse, [j.lanusse@enginsoft.fr](mailto:j.lanusse@enginsoft.fr), pour plus d'information

10 June – Seminar Product Process Integration – Paris. How to innovate and improve your production processes! A Seminar hosted by EnginSoft France and EnginSoft Italy [www.enginsoft-fr.com](http://www.enginsoft-fr.com)

15-21 June – International Paris Air Show, Le Bourget – Paris. Meet EnginSoft France in the Exhibition grounds, Hall 4 Stand n° 4CD77! EnginSoft France vous présente Flowmaster V7 Aerospace et modeFRONTIER au Centenaire du Salon International de l'Aéronautique et de l'Espace. [www.paris-air-show.com](http://www.paris-air-show.com)

30 June-1st July - The Ter@tec'09 Forum. Supélec, 91192 Gif-sur-Yvette. Come and visit us at the EnginSoft France Booth in the exhibition! <http://www.teratec.eu/gb/forum/index.html>

17 September – Seminar Product Process Integration – Paris. How to innovate and improve your production processes! A Seminar hosted by EnginSoft France and EnginSoft Italy. [www.enginsoft-fr.com](http://www.enginsoft-fr.com)

02-03 December – International Conference "The spark ignition engine of the future". Strasbourg – INSA. Arnaud Bussière, EnginSoft France, presenting "Robust Optimization of a high pressure pump flowrate". [www.sia.fr](http://www.sia.fr). For more information on the above events and to make an appointment, please email: [j.lanusse@enginsoft.fr](mailto:j.lanusse@enginsoft.fr)

## SWEDEN

15-17 June - Svenska Mekanikdagarna" (The Swedish days of Mechanics). Soedertaelje/Stockholm.

Tomas Andersson of A-Dev, partner of EnginSoft Esteco Nordic, presenting on "Multi-objective optimization of an automotive aluminium part". [www.smd2009.se](http://www.smd2009.se). For more information, please contact Håkan Strandberg, [hakan.strandberg@esteconordic.se](mailto:hakan.strandberg@esteconordic.se)

## UK

modeFRONTIER Workshops at Warwick Digital Lab. 3 & 27 July, 25 August, 25 September, 20 October, 17 November, 9 December.

Technical Seminar on Optimization at Warwick Digital Lab. Dates will be announced shortly !

25-26 July - modeFRONTIER Training Course for Academic Specialists. Nottingham University. To register or to express your interest for the above events, please visit: [www.enginsoft-uk.com](http://www.enginsoft-uk.com) or contact: [b.patel@enginsoft.com](mailto:b.patel@enginsoft.com)

2-4 September 2009 - IMC26. Trinity College Dublin, Ireland. EnginSoft UK will present at the Conference for Energy Efficient and Low Carbon Manufacturing. [www.imc26.com](http://www.imc26.com)

15-16 September - Infoworks User Conference. Reading. EnginSoft UK presenting a case-study for the Water industry. [www.wallingfordsoftware.com/uc09](http://www.wallingfordsoftware.com/uc09)

11-13 November - WaPUG Autumn Meeting & Conference Blackpool. EnginSoft UK presenting their case-study for the Water industry. <http://www.ciwem.org/groups/wapug/>

## SPAIN

7-8 May - CIRP Conference on Modeling of Machining Operations. Donostia-San Sebastián - Spain. APERIO Tecnología tendrá un stand en este congreso organizado por el High Performance Cutting Research Group de la Universidad de Mondragon! [www.mondragon.edu/12cirpcmmo](http://www.mondragon.edu/12cirpcmmo). For more information, please email: [g.duffett@aperiotec.es](mailto:g.duffett@aperiotec.es)

## GERMANY

6-7 July – EASC 2009 - 4th European Automotive Simulation Conference.

Hilton Munich Park Hotel, Munich. modeFRONTIER-related presentations will include: "Use of the CFD for the Aerodynamic Optimization of the Car Shape: Problems and Application" and "Optimal Design of a Solid Oxide Fuel Cell for Hybrid Vehicle Application"

Presentations by EnginSoft on applications involving ANSYS: "Modelling of Condensate Formation and Disposal inside an Automotive Headlamp" and "Thermal-Structural Analysis on Cylinder Head using Workbench Platform as Calculation Environment".

Come and discuss these applications and other topics at the EnginSoft booth! <http://easc.ansys.com>



22 September - Seminar Process Product Integration. EnginSoft GmbH, Frankfurt Office. How to innovate and improve your production processes! A Seminar hosted by EnginSoft Germany and EnginSoft Italy. For more information, please contact: [Andrea.Hauschopp@esteco-germany.com](mailto:Andrea.Hauschopp@esteco-germany.com). Stay tuned to [www.enginsoft-de.com](http://www.enginsoft-de.com)

18-20 November – ANSYS Conference & 27th CADFEM Users' Meeting. Congress Center Leipzig. EnginSoft will be presenting in the LS-DYNA Session, and welcome Conference attendees at the EnginSoft Booth. Please stay tuned to: [www.usersmeeting.com](http://www.usersmeeting.com)

#### TURKEY

18-21 June – 5th International Conference and Exhibition on Design and Production of Machines and Dies / Mold Pine Bay Hotel Kusadasi, Aydin.  
[www.diemold.org](http://www.diemold.org)

5-6 November - 14th Conference for Computer-Aided Engineering and System Modeling Kultur ve Kongre Merkezi, METU, Ankara.  
[www.figesc.com.tr/conference/2009/](http://www.figesc.com.tr/conference/2009/)

#### GREECE

15 June - 3rd PhilonNet CAE Conference 2009. Athens. Presentation by EnginSoft, Sponsor of the For more information, please stay tuned to: [www.philonnet.gr](http://www.philonnet.gr)

16-19 June - NAFEMS World Congress 2009. Creta Maris Conference Centre - Crete. EnginSoft informs about: CAE Computer Aided Engineering, VP Virtual Prototyping, Advanced

Training and Education for Engineers and Innovation in Simulation. Hear about modeFRONTIER, the CAE Academy and unique opportunities for Training and Recruitment at the EnginSoft booth!

#### 18th June - Session 7A.

"Multi-Objective Optimization of Multibody Systems in Circuit Breaker Applications". Dr. S. Kotilainen, ABB Switzerland. (Co-author: Dr. Luca Fuligno, EnginSoft)

#### 18th June - Session 7B.

"Education and Training 3", a Workshop conducted by EnginSoft in collaboration with the NAFEMS Education and Training Working Group: The CAE Academy – EnginSoft's Training and Recruitment Initiative.

Please refer to the preliminary Congress Agenda: <http://www.nafems.org/congress/>

#### EUROPE, VARIOUS LOCATIONS

modeFRONTIER Academic Training

Please note: These Courses are for Academic users only. The Courses provide Academic Specialists with the fastest route to being fully proficient and productive in the use of modeFRONTIER for their research activities.

The courses combine modeFRONTIER Fundamentals and Advanced Optimization Techniques. For more information, please contact Rita Podzuna, [r.podzuna@enginsoft.it](mailto:r.podzuna@enginsoft.it)

To meet with EnginSoft at the above events, please contact us: [info@enginsoft.com](mailto:info@enginsoft.com)

## PETROBRAS Work using modeFRONTIER wins DOT 2008 Award

Dr. Mauro Costa de Oliveira of the Naval Architecture and Marine Engineering Department at the Petrobras Research Center (CENPES) has been using modeFRONTIER together with the stability program SSTAB and the hydrodynamics analysis tool, WAMIT, to size offshore structures since 2004. Last year, he presented some of this work at the Deep Offshore Technology Conference in Houston, in a paper titled "Offshore Platform Sizing Optimization using Genetic Algorithms", which subsequently earned the award for the conference paper using the most innovative technology. Mauro, a naval architect and the first user of modeFRONTIER in Brazil, created a workflow with only 5 geometric parameters, but numerous constraints, and the structure was analyzed for multiple conditions: quayside, transit and 2 different operating conditions. The objective was to minimize the vertical wave-induced motions that cause

fatigue damage to the oil production risers, and to achieve this, Mauro used the NSGA-II algorithm in modeFRONTIER, with a population size of 10, and 500 generations. His excellent paper showed how using modeFRONTIER allowed him to obtain designs which not only gave low values of fatigue, but also met all the constraints imposed by the different operating conditions to which the platform was to be subjected.

The procedure described in the paper has been applied to the P-55 semi-submersible platform, currently under construction.

For more information, and to download the paper Offshore Platform Sizing Optimization using Genetic Algorithms by Dr Mauro Costa de Oliveira - Petrobras CENPES, please visit the ESTECO srl website: [www.esteco.com](http://www.esteco.com)



# Metodi numerici e strumenti per l'ottimizzazione multidisciplinare

Negli ultimi anni assistiamo ad un costante incremento nell'utilizzo di strumenti per la simulazione numerica e ad un crescente impiego di tecniche di ottimizzazione; è ormai possibile simulare fenomeni di complessità elevata con modelli che riproducono sempre più fedelmente la realtà fisica. Purtroppo però, i problemi reali risultano particolarmente complessi in quanto sono generalmente non lineari e hanno natura multidisciplinare. Questo significa che i problemi reali incorporano un numero sempre maggiore di discipline tra loro fortemente dipendenti. Alcuni dei più moderni approcci all'ottimizzazione multiobiettivo risultano

interpretare i risultati ottenuti, tecniche di supporto alle decisioni e metodi di analisi della robustezza e delle incertezze.

L'approccio all'ottimizzazione multidisciplinare verrà dimostrato attraverso una serie di casi di successo quale, tra gli altri, l'ottimizzazione di un canale di raffreddamento di un'automobile con miglioramento delle performance e scelta della soluzione robusta.

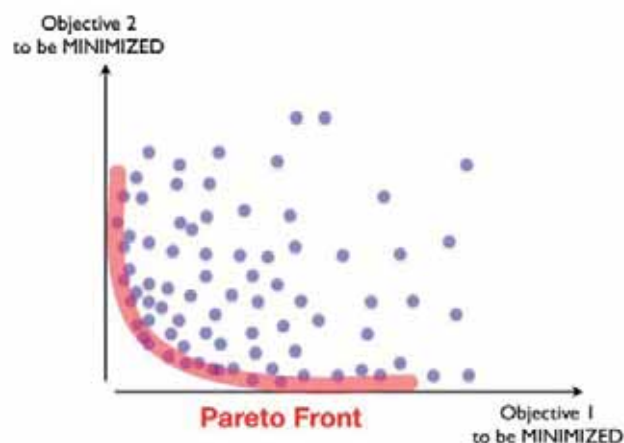
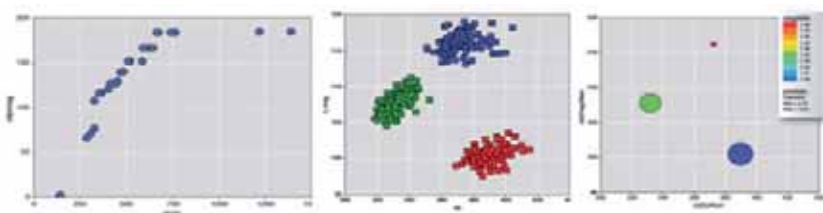
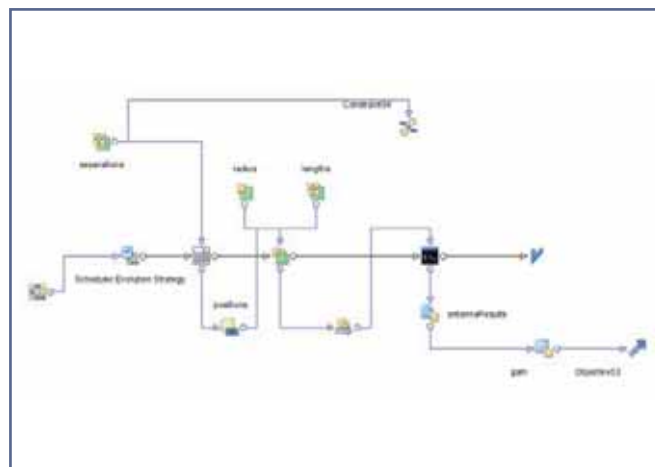


## AVVISO DI SEMINARIO Colloquia per il Calcolo Scientifico

**6 luglio 2009, ore 15:00, Aula Magna della  
Facoltà di Ingegneria  
via Loredan 20, Padova**

particolarmente adatti alla risoluzione di questi problemi; tali tecniche cercano le soluzioni ottimali che rappresentino un buon compromesso tra le migliori soluzioni delle singole discipline. Questo seminario descriverà l'importanza dell'utilizzo dell'ottimizzazione multidisciplinare e dimostrerà come questo approccio porti a soluzioni diverse e migliori rispetto alle soluzioni ricavate con tecniche di ottimizzazione più "classiche" e monodisciplinari.

Verrà dimostrato come gli strumenti PIDO (Process Integration and Multi-Objective Design Optimization), quali ad esempio modeFRONTIER, permettano di descrivere la logica del processo progettuale e consentano di gestire l'ottimizzazione multiobiettivo e multidisciplinare con estrema facilità. Un software che implementa la tecnologia PIDO deve svolgere funzioni complementari quali ad esempio la formalizzazione e la gestione del workflow e l'integrazione di software di simulazione. Inoltre, tali tecnologie devono comprendere un insieme di metodi di ottimizzazione nonché tecniche di interpolazione e grafici che permettano di



# CAE Trends in Japan

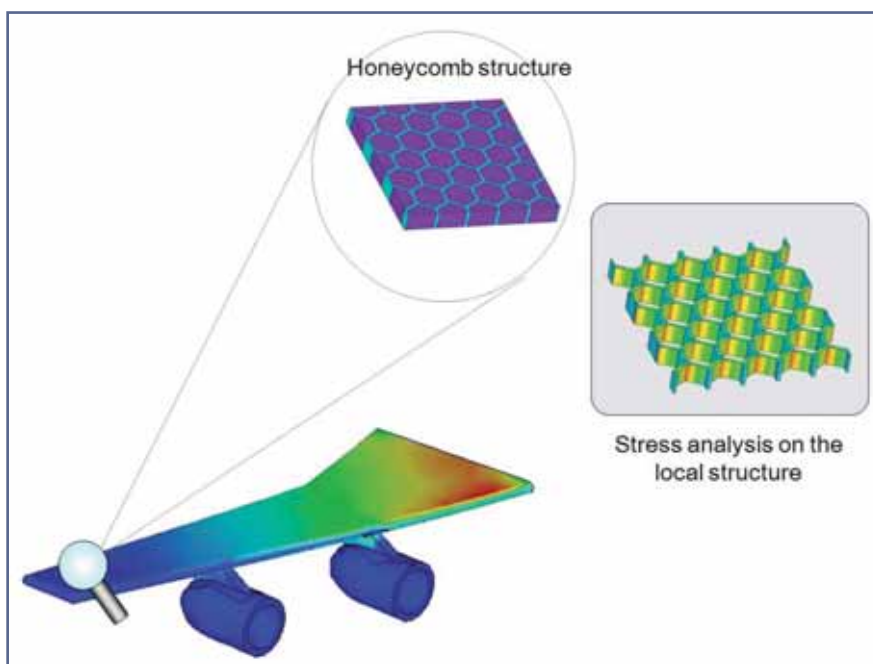
## CAE - the key for Japanese manufacturing

The manufacturing industry has been the main sustaining factor for the Japanese economy for a long time. Today, Japan's manufacturing output amounts to 330 trillion Yen, more than 2.5 trillion Euro per year, whereas more than 50% come from industries related to transport and machinery, such as automotive, electrical machinery, electrical devices, machinery and chemical engineering.

The use of CAE in the Japanese manufacturing industry dates back to the 1960s and 1970s, a time when the first commercial CAE software products had been introduced to the market. The first rather limited applications developed in the nuclear power, aerospace, and automotive sectors. In the 1980s, CAE technologies and knowledge spread out to other industries, especially to electrical machinery and devices, which had been growing dramatically as a consequence of computer hardware downsizing and huge revenue growth in the electronics sector. This era also saw the multiplication of possible CAE physical areas. Then in the 1990s, the market demand for the easy-to-use environment had increased. CAE on the PC was realized, the Japanese GUI and manual were provided. A number of CAE products targeted at designers were introduced with various mid-range 3DCAD products released later in the 90s. These factors stimulated the CAE utilization in the early stage of the design process, and in the beginning of the 2000s, led to a widespread use and implementation in nearly all areas of product development. It is interesting to note that Japan implemented such CAE technologies and simulation methods for design engineers earlier than other countries. One reason for this might be Japan's economic structure with industries that rely on shorter product development cycles and more diverse product models, such as, for example, electronics and machinery

where simulation became indispensable at an early stage.

In the 2000s, polarization in CAE accelerated. Firstly, this was due to the necessity to reduce design cycles by "designers" as we explained already. The second reason was the continuous demand for CAE and its applications to the evaluation process prior to production, to pursue higher quality by substituting prototype testing which requires complicated physical models. The so-called "frontloading CAE" has been easily accepted by the market and it rapidly spread, mainly because of its short implementation times and due to the fact that it delivers effects earlier than traditional CAE. Indeed, frontloading CAE can be seen as the driving force in the Japanese CAE market today. Moreover, we also notice a growing demand for traditional CAE. Behind the trend is the fact that frequent recalls of automotive and electronic products in Japan, since the middle of the 2000s, have heightened companies' awareness of avoiding design and product deficiency. This is also one of the reasons why Japanese companies realized quickly that CAE technologies are essential to develop safe, high-quality and globally competitive products. At the same time, in the 2000s', nearly all industries began to pay attention to environmental technologies and innovative approaches, factors which have changed manufacturing processes dramatically. Environmental related issues are also key reasons for many companies for the implementation of CAE into their production cycles. With the global financial crisis since 2008, CAE is also discussed by many industry experts as a solution for cost savings and business downsizing. Based on this standpoint, the 2000s' present a huge leap in the CAE history of Japan. Today, CAE is the key for Japanese manufacturing. Its purpose and objectives are discussed by corporate managements. CAE is part of the core strategies of Japanese manufacturing companies.



Multiscale Simulation

## Japanese unique MONODUKURI

MONODUKURI is the Japanese expression for manufacturing which has been used very often since 1990. Generally it is translated as "production" or "manufacturing" in English, but it is also used often in discussions about Japanese engineering spirit and traditional manufacturing. We Japanese are good at delivering quality to a product and to new product developments by applying technology. This is why we keep the original Japanese expression MONODUKURI for this phenomenon as with other well-known Japanese traditions, such as, for example: BONSAI (the art of aesthetic miniaturization of trees) and KAISEKI (a type of art that balances the taste, texture, appearance and



colors of food). Actually, all these are unique cultures to build a detailed microcosm in a specific space. While we return to our main discussion now, we keep in mind that such culture is alive in a variety of industrial product developments. For instance, we do not see Japanese-made passenger aircrafts flying today, however, inside an aircraft body, there are numerous Japanese components and materials. For example, when we think of the world's no 1 mobile audio player, its well polished stainless cover is made by a midsize company in a province of Japan. Many diverse products are developed and manufactured in Japan by applying leading environmental technology, such as hybrid or electric vehicles, solar panels etc. In Japanese MONODUKURI, we can see the most complex use of CAE in a broad range of physical areas: structural and fluid dynamics but also thermal, electrical, magnetic, acoustics and multi-body dynamics have been simulated in a general way, and the idea of multiphysics has been adopted already many years ago. In addition, multiscale simulation to evaluate the local micro area for new material development, has been discussed at times in recent years. Moreover, significant efforts for promoting CAE by the combination of electrical control and mechanical control have been undertaken. These two areas have developed in different ways, however, their coupling is not so easy with regard to the different technologies and corporate manufacturing structures involved. Still, many experts in the field agree that their combination will evolve and become an indispensable technology in the future. What remains to be seen is a solution for the improvement of the design and manufacturing process. In this context, the first approach considered is optimization to streamline existing CAE evaluation cycles and to guide us to the optimized design or process which cannot be found in the

**JSAE Automotive Engineering Exposition**

The 2009 Automotive Engineering Exposition organized by the Society of Automotive Engineers of Japan, Inc. (JSAE) was held at Pacifico Yokohama from 20-22 May 2009.

Despite concerns about the recent financial crisis and decreasing numbers of visitors, the organizers welcomed more than 50.000 visitors whose attention was focused in particular on environmental technologies, such as, for example hybrid vehicles.

[http://www.jsae.or.jp/expo/index\\_e](http://www.jsae.or.jp/expo/index_e)

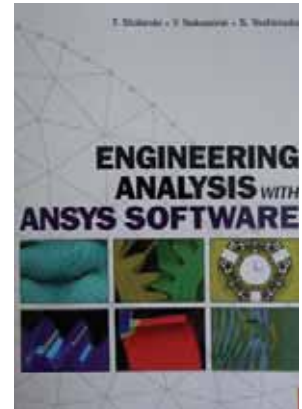


JSAE is an annual exposition organized by the Society of Automotive Engineers of Japan, Inc. since 1992

**The book "ENGINEERING ANALYSIS WITH ANSYS SOFTWARE"**

Tadeusz Stolarski, Professor of Mechanical Engineering, Brunel University, UK  
 Y. Nakasone, Professor in the Department of Mechanical Engineering, Tokyo University of Science  
 S. Yoshimoto, Professor in the Department of Mechanical Engineering, Tokyo University of Science

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For more information about the book and to order a copy, please visit:  
[www.elsevier.com](http://www.elsevier.com)

standard simulation flow. The second approach is to realize process lifecycle management as the base to not only manage the entire design and manufacturing process but also carry out thorough quality control and to reduce human error.

**Education for CAE engineers**

When we speak about CAE, another important topic is education and life-long learning for all those using the technologies. With the fast growing demand for CAE expertise and software since the 2000s, education and formation for the same, have become a major topic of interest for industry. CAE is much closer to engineers in the manufacturing industries than ever before because of today's easy-to-use environment which had been eagerly awaited. However, at the same time, training and hands-on education for young engineers as well as initiatives for skill transfer from experienced engineers are of utmost importance. As a matter of fact, today, Japanese companies using CAE have established and developed their own educational systems and the intranet for sharing know-how internally by trial and error. However, except for some big players, CAE is most often used in a very closed environment and therefore, the access to necessary information or techniques for the effective use of the technologies, is limited. Users' meetings held by CAE vendors, service providers and engineering associations have always been one solution to offer interactive platforms to CAE users. Moreover, some networking opportunities to exchange knowledge, expertise, experiences, new ideas and latest information have been created in recent years by industry, research, the academia and CAE vendors. These networks have a different approach than existing conferences as they offer open and productive discussions on, for example, real problems and failure stories and how to better implement CAE while avoiding

dependence on specific software. Today, in 2009, young engineers who start using CAE can choose from a number and variety of seminars and trainings which focus on the combination of theory and practice. Although such initiatives may not always provide all the answers for today's complex simulation scenarios, it is to their credit that they have contributed to the growing use of CAE in Japan in recent years. Of course, there are still challenges to be met from various viewpoints, but - without doubt - CAE has become a vital part of today's manufacturing society and will continue to sustain Japan's core industry, one of the largest in the world.

### Introduction to CAE Book

Nowadays, we see many different CAE books on the basic theories and general ideas for CAE education and training. Some books in particular, are widely accepted by engineers because of their practical content including hands-on examples of world leading CAE software. The "ENGINEERING ANALYSIS WITH ANSYS SOFTWARE" is a hands-on guide with an innovative and clear tutorial based approach using ANSYS. The original idea actually comes from a Japanese text book which was written by some ANSYS users, professors and the Japanese distributor in 2001.

Unlike any other book in the CAE area, it has sold 10.000 copies over the past eight years and has been used across a wide range of industries and universities - as the essential guide to CAE. A few years after its first edition appeared, the main authors of the guide, Prof. Yoshimoto, Prof. Nakasone of Tokyo University of Science, continued working on a new publication of a more sophisticated English version for worldwide use, with Prof. Stolarski of Brunel University in the UK. The new CAE book was finally published in 2006. Opening with an introduction to the principles of the finite element method, the book then presents an overview of ANSYS technologies before moving on to cover key applications areas, such as stress analysis, dynamics of machines, fluid dynamics problems, thermo mechanics, contact and surface mechanics in detail. With its detailed step-by-step explanations, extensive worked examples and sample problems, this book will develop the reader's understanding of FEA and their ability to use ANSYS's software tools to solve their own particular analysis problems, not just the ones set in the book. This is really the essential guide to learning engineering analysis using ANSYS for beginners and experienced users alike.

*Akiko Kondoh, Consultant for EnginSoft in Japan*

## Advanced casting design of automotive components



The Mini-Master will be hosted by the Department of Industrial System Management (DTG) - University of Padova - and held in Vicenza on June 22nd-26th, 2009.

The International NADIA Mini-Master consists of a five day intensive course on advanced casting design of automotive components, in which each day is dedicated to a specific topic:

- Fundamentals of solidification and casting technology
- Processing and properties of cast alloys
- Fundamentals of numerical modelling of casting and heat treatment processes
- CAE intergrated tools for the development of automotive components
- Automotive components by intelligent processing

The idea is to give a general overview on fundamentals, and to illustrate how such information can be used to achieve "Intelling processing" of real automotive components through innovative solutions, and in particular by the use of CAE integrated tools. This structure reflects the NADIA activity plan that aims at exploiting the potential of European SMEs for the production of light alloys based components for transport, employing the intelligent processing approach, taking advantage of methods and design strategies coming from fundamental and applied research objectives. This course shows the commitment of the NADIA consortium to share the knowledge and expertise applied to this Integrated Project, and to illustrate innovative and successful methodologies in design, manufacturing and R&D of automotive light metal castings. The

### The NADIA Consortium, in the framework of its IP project, announces the INTERNATIONAL MINI MASTER

mini master, intended for scientists and engineers working in Industry or Academia, interested in these topics, is organized by the NADIA consortium

and is presented by leading Europeans experts from Industry and Academia. It is also open to external participants.

The detailed agenda can be downloaded from: <http://www.nadiaproject.org/announces>

The Registration form is on-line at:

<http://www.nadiaproject.org/node/72>

Registration deadline: 15th June 2009

### Organised in the frame of EU NADIA Project



New Automotive components Designed for and manufactured by Intelligent processing of light Alloys



6th Framework Program NMP Research Area Contract 026563-2

with the cooperation of



Associazione Italiana di Metallurgia



Fondazione Studi Universitari di Vicenza



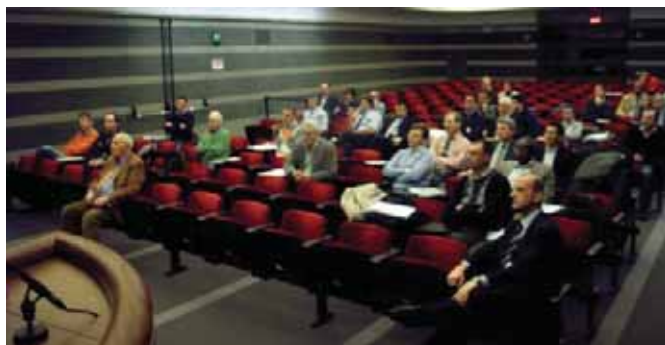
Intelligent Manufacturing Systems



# A Lecco è stato fatto il punto sulle tecniche più avanzate di ottimizzazione di processo\prodotto nel campo dello stampaggio a caldo di acciaio

Venerdì 3 aprile il mondo dello stampaggio a caldo di acciaio si è dato appuntamento nella sede della Confindustria di Lecco. Una cinquantina di persone, in rappresentanza di una trentina di aziende che si occupano di stampaggio, di progettazione degli stampi e della costruzione di presse, hanno accolto l'invito di Enginsoft e dello Sportello Innovazione per un pomeriggio tecnologico nel quale è stato fatto il punto delle più avanzate tecniche di ottimizzazione di processo e prodotto.

A fare gli onori di casa è stato il sig. Mauro Medola dello Sportello Innovazione di Confindustria Lecco, che ha sottolineato come, in questo momento di difficoltà, Confindustria faccia ogni sforzo per proporre alle aziende degli incontri per venire a conoscenza di strumenti innovativi, come ad esempio la simulazione, in grado di farle crescere e migliorare in vista della auspicata ripresa. A seguire, piatto forte dell'incontro sono stati gli interventi di Piero Parona, con una descrizione delle molteplici attività di Enginsoft nel campo della prototipazione virtuale e dell'ing. Marcello Gabrielli, sempre di Enginsoft, che ha riguardato le tecniche di simulazione numerica del processo di stampaggio a caldo di acciaio con il software Forge di Transvalor. A partire da una analisi del modo attuale di progettare le sequenze di stampaggio, si è costruito un percorso innovativo dove, grazie alla simulazione applicata ad esempi reali su particolari noti ai presenti, si sono evidenziati tutti i vantaggi concreti ottenibili. Il sig. Ennio Scarduelli di Casartelli Antonio Srl, utilizzatore da alcuni anni di Forge, ha portato delle esperienze dirette, dove la simulazione ha effettivamente consentito di risolvere dei problemi e di migliorare il proprio processo e prodotto. Non meno importante è stato l'intervento dell'ing. Stefano Fongaro della FICEP, che ha fatto il punto della tecnologia relativa alla costruzione di linee di stampaggio sempre più efficienti e in termini di sfruttamento della potenza e di recupero dell'energia utilizzata. A completare il tutto, una dimostrazione dal vivo di utilizzo di Forge, curata dall'ing. Andrea Pallara di Enginsoft, ha evidenziato come questi strumenti siano ormai molto facili da utilizzare, sia nella fase di preparazione delle simulazioni, che nella fase di interpretazione dei risultati.



Un appuntamento importante, dicevamo, dove alle presentazioni previste in agenda è seguito un partecipato dibattito tra i relatori ed il pubblico. Le risposte del sig. Scarduelli della Casartelli Srl, hanno evidenziato come questi strumenti siano realmente in grado di dare agli utilizzatori una maggior coscienza del proprio modo di produrre e come, grazie ai concreti vantaggi ottenibili, sia possibile ammortizzare l'investimento in tempi molto rapidi. Per quanto riguarda FICEP, l'ing. Fongaro ha sottolineato come sia necessario, anche da parte di chi costruisce le linee di stampaggio, appoggiarsi a questi strumenti per fornire un servizio "chiavi in mano" ai propri clienti. Volendo riassumere, è emerso come, in questo momento di difficoltà legata alla congiuntura economica, sia necessario cogliere l'occasione per investire su questo genere di strumenti, in grado di dare maggiore competenza e conoscenza del proprio processo ai propri reparti di progettazione e produzione, ma anche utilizzabile come potente mezzo di promozione della propria immagine e strumento di co-design nei confronti dei propri clienti.

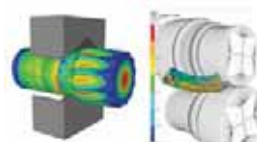
## PROSSIMI WORKSHOP

[www.enginsoft.it/eventi](http://www.enginsoft.it/eventi)

Per informazioni: [info@enginsoft.it](mailto:info@enginsoft.it)

24 Giugno 2009 - Zona Vicenza

**SIMULAZIONE DEI PROCESSI DI LAMINAZIONE A CALDO DI PRODOTTI LUNGHI, LAMINAZIONE CIRCOLARE E FORGIATURA**



25 Settembre 2009 - Zona Bergamo

**SIMULAZIONE DEL PROCESSO DI STAMPAGGIO A FREDDO DI VITERIE E MINUTERIE METALLICHE**



# Il mondo dello stampaggio a caldo di ottone ed alluminio si è dato appuntamento a Bergamo per fare il punto sulle tecniche più avanzate di ottimizzazione di processo.

Dopo il successo del primo appuntamento di Lecco, il 3 aprile, dedicato all'acciaio, giovedì 7 maggio Enginsoft ha voluto dedicare un pomeriggio al mondo dello stampaggio a caldo dei non ferrosi. Grazie all'importante collaborazione con Hydromec, ben conosciuto produttore di presse per l'ottone, l'appuntamento nella sede di Bergamo di Enginsoft ha visto la partecipazione di oltre quaranta persone, in rappresentanza di una trentina di aziende che si occupano di stampaggio, di progettazione degli stampi e della costruzione di presse.

In questo pomeriggio tecnologico è stato fatto il punto delle più avanzate tecniche di ottimizzazione di processo e prodotto. A fare gli onori di casa è stato Piero Parona, Sales Manager di Enginsoft, con una descrizione delle molteplici attività di Enginsoft nel campo della prototipazione virtuale. A seguire il Dott. Franzosi del Consorzio Ruvaris ha illustrato le attività del



consorzio nell'ambito della ricerca su i non ferrosi, ottone in primis, alla luce delle ultime normative internazionali. Si è entrati quindi nel vivo dell'argomento con gli interventi dell'ing. Marcello Gabrielli, sempre di Enginsoft, che hanno riguardato le tecniche di simulazione numerica del processo di stampaggio a caldo dei non ferrosi con il software Forge di Transvalor. A partire da una analisi del modo attuale di progettare le sequenze di stampaggio, si è costruito un percorso innovativo dove, grazie alla simulazione applicata ad esempi reali su particolari noti ai presenti, si sono evidenziati tutti i vantaggi concreti ottenibili. Le recenti modifiche apportate al software grazie ad Enginsoft ed agli utilizzatori italiani, consentono ora di simulare cinematiche anche molto complesse, con stampaggi a forare su cuscino ed a campana, ottenendo risultati molto precisi sui difetti nel pezzo, anche nella formazione di dettagli molto piccoli come le scritte. Le testimonianze dell'ing. Fabio Fecit della Fonderia F.lli Maspero Srl e dell'ing. Lorenzo Oldoni della Zucchetti Mario SpA, utilizzatori di Forge, hanno illustrato come la simulazione ha effettivamente consentito di risolvere una varietà di problemi qua-

litativi e di migliorare il proprio processo e prodotto, sia per lo stampaggio di ottone, sia per quello dell'alluminio, dove la minore esperienza



spesso porta a commettere errori più critici. In particolare è risultato evidente come chi abbia intrapreso la strada di "prototipare virtualmente" i propri prodotti oggi non possa più rinunciare a questa metodologia basata su Forge, visti i sensibili risparmi di tempo ed il guadagno in qualità ottenibili. Il contributo dell'ing. Verzeletti di Hydromec, storica leader nel campo della produzione di presse per lo stampaggio di ottone, ha mostrato come grazie a Forge, utilizzato attraverso la collaborazione con Enginsoft, sia possibile anche valutare a priori se una macchina è in grado di produrre un certo particolare, fornendo quindi un servizio "chiavi in mano" ai propri clienti.

A completare la sezione tecnica, una dimostrazione dal vivo di utilizzo di Forge, curata dall'ing. Andrea Pallara di Enginsoft, che ha impostato il caso di un corpo in ottone con tre punzoni a forare su cuscino, gentilmente concesso da Brawo SpA, anch'essa utilizzatrice di Forge. La demo ha evidenziato come questi strumenti siano ormai molto facili da utilizzare, sia nella fase di preparazione delle simulazioni, che nella fase di interpretazione dei risultati.

Un appuntamento importante, dicevamo, dove alle presentazioni previste in agenda è seguito un partecipato dibattito tra i relatori ed il pubblico, nel quale gli utilizzatori presenti hanno evidenziato come questi strumenti siano realmente in grado di dare una maggior coscienza del proprio modo di produrre e come le esperienze fatte con Forge siano utili sia a far crescere molto rapidamente chi si avvicina al mondo dello stampaggio, ma anche che divengono patrimonio dell'azienda. Ultimo aspetto non meno importante è il fatto che, grazie ai concreti vantaggi ottenibili, è possibile ammortizzare l'investimento in tempi molto rapidi.



# La Progettazione di uno Stampo per Pressocolata mediante Simulazione: Nuove Pratiche di Ottimizzazione e Integrazione CAD-CAE

Dedicato al mondo degli stampisti e a quello delle fonderie per pressocolata si è svolto a Bergamo il Workshop dal titolo: LA PROGETTAZIONE DELLO STAMPO PER PRESSOCOLATA MEDIANTE SIMULAZIONE: NUOVE PRATICHE DI OTTIMIZZAZIONE E INTEGRAZIONE CAD-CAE

## WORKSHOP 8 Maggio, EnginSoft Bergamo

L'incontro proposto da EnginSoft, con la partecipazione di Vero Italia e di FZ Zanetti, aveva come obiettivo di mostrare, attraverso un percorso illustrativo delle varie fasi progettuali, i vantaggi derivanti da una metodologia di simulazione integrata con la progettazione e finalizzata all'ottimizzazione del ciclo produttivo che conduce dal modello di un oggetto alla realizzazione del relativo stampo.

Le fasi di questa metodologia, ciascuna evidenziata nel corso dell'incontro, traducono il moderno concetto di innovazione di progetto, nell'ottica di quella che, come ha sottolineato Piero Parona, viene oggi definita "Prototipazione Virtuale" o, in Inglese, "Digital Prototyping".

Non è un caso che l'attività svolta da EnginSoft abbia un crescente riscontro nelle aree dei "processi tecnologici", dove il supporto della simulazione numerica è diventata sempre più indispensabile per migliorare la qualità dei prodotti, ottimizzando il processo produttivo e riducendone l'entità degli scarti.

Simulare un processo di pressocolata significa considerare virtualmente ogni dettaglio delle condizioni di processo, con l'obiettivo di poter conferire al componente finale le proprietà strutturali e prestazionali richieste, simili talvolta a quelle che si potrebbero ottenere con altri processi più costosi (es. thixocasting e squeeze casting). In relazione a tali obiettivi, la simulazione deve permettere di trarre indicazioni sulla posizione di eventuali difettosità e sulla distribuzione delle tensioni residue, andando così a identificare il rapporto fra livello di difettosità e di resistenza meccanica dell'oggetto pressocolato.

La combinazione di due sistemi software, rispettivamente dedicati alla simulazione e all'ottimizzazione, ha portato alla nascita di MAGMAfrontier che supporta il progettista nell'elaborazione di un modello ottimizzato, grazie al bilanciamento della fase di riempimento e alla conseguente riduzione dei di-

fetti, in linea con quelli che possono essere definiti i reali obiettivi progettuali in questa area.

La struttura logica di MAGMAfrontier, che sfrutta l'architettura e le routine di ottimizzazione originali di modeFRONTIER, lo rende simile a un sistema esperto che, con un approccio basato sull'esperienza codificata nello stesso software, consente di definire lo schema strutturale del processo e di ottimizzarne i parametri d'impiego, grazie a funzionalità che si avvalgono di specifici template per l'impostazione delle varie strategie scelte dall'utente.

Con MAGMAfrontier il progettista viene supportato nella definizione della geometria e dei parametri di processo relativi al ramo di colata, ottimizzando la qualità del getto e minimizzando al tempo stesso l'eventualità di difetti interni alla struttura del componente.

Il sistema supporta l'utente nell'esecuzione di un'analisi di sensitività, che consente di stabilire il livello d'incidenza di ogni variabile geometrica sul risultato finale; il sistema presuppone pertanto l'acquisizione, tramite import da sistema CAD, delle geometrie relative al progetto da analizzare.

Come ha evidenziato Oscar Belleri di FZ Zanetti, l'integrazione di MAGMAfrontier con il sistema CAD di progettazione è biunivoca, dal momento che, una volta condotta l'analisi e l'ottimizzazione del ramo di colata, la stessa geometria definitiva può essere trasferita nuovamente al sistema CAD per integrarla con il progetto della matrice dello stampo.

Per informazioni:  
Piero Parona - EnginSoft  
info@enginsoft.it



# Olimpiadi della Matematica XXV Finali Nazionali 2009

Da venerdì 8 a domenica 10 Maggio si è svolta a Cesenatico la XXV finale nazionale delle Olimpiadi di Matematica patrocinate dal Ministero della Pubblica Istruzione. Nel corso di tre intense giornate si sono svolte sia la finale della gara individuale che due semifinali e la finale della gara a squadre. Alla finale individuale erano invitati 300 ragazzi scelti per mezzo di due successive gare di selezione che hanno coinvolto 300.000 tra i migliori studenti di matematica di tutte le scuole medie superiori d'Italia. Per la fase finale della gara a squadre si erano invece qualificati 74 team, ognuno composto da 7 ragazzi, in rappresentanza di altrettante scuole medie superiori italiane.



Da sinistra: Gabriele Viaggi, Marco Guarguaglini, Camilla Pezzica, Francesco Salvatori, Erica Pezzica, Stefano Pegoraro, Gabriel Giorgieri.

## EnginSoft presente come sponsor unico del Liceo Scientifico Marconi di Carrara

Nel pomeriggio di venerdì il settembello del Liceo Scientifico Marconi di Carrara è sceso in campo nella seconda delle due semifinali a 37 squadre. Il Marconi si è presentato ai nastri di partenza con capitano Francesco Salvatori (classe 5), consegnatore Camilla Pezzica (classe 5), Gabriel Giorgieri (classe 5), Stefano Pegoraro (classe 5), Erica Pezzica (classe 4), Marco Guarguaglini (classe 3) e Gabriele Viaggi (classe 3), la stessa formazione che a Marzo aveva vinto a Genova la prestigiosa Coppa Fermat 2009. Al termine della propria semifinale il Marconi era l'unica squadra che riusciva a risolvere tutti i problemi proposti (l'ultimo dei quali ad una manciata di secondi dal termine!) e quindi vincendo per distacco su tutti gli altri forti concorrenti.

La mattina di sabato la squadra carrarese, campione in carica, scende in campo per disputare la finale a 36 squadre e tentare di bissare il risultato dello scorso anno. Purtroppo però una



Durante la gara

iniziale scelta sfortunata del problema jolly (dove i punteggi e le penalità vengono raddoppiati) ed alcuni errori ripetuti in un altro problema particolarmente complesso, impedivano ai nostri di terminare in vetta nella finale che è stata meritatamente vinta dal Leonardo da Vinci di Treviso. Anzi, al termine di un concitato finale di gara, nel vano tentativo di raggiungere in extremis la vetta, il Marconi azzardava senza successo alcune risposte nei due problemi che potevano ancora sovvertire la classifica e scivolava così di alcune posizioni in classifica terminando la gara con un comunque onorevole sesto posto.

Sottolineiamo poi che tre ragazzi del Marconi hanno anche partecipato alla finale nazionale individuale ottenendo ottimi risultati, nella fascia delle medaglie d'oro (assegnate ai migliori 25) Francesco Salvatori si è infatti splendidamente classificato decimo assoluto. Notevole però è stato anche il risultato di Gabriel Giorgieri che ha preso una medaglia d'argento "pesante" arrivando ad un soffio dall'ottenere anche lui un oro. Di assoluta soddisfazione infine anche il risultato di Marco Guarguaglini che si è visto assegnare anche lui una medaglia d'argento.

## CURIOSITÀ

Fin dalla partenza in treno dalla stazione di Carrara al termine di tutte le gare tenute a Cesenatico, la squadra del Liceo Marconi è stata seguita da una troupe della RAI (2 inviati + 3 operatori). Questo perché nella nuova edizione di "Presa Diretta", il programma condotto da Riccardo Iacona su Rai3 la domenica sera in prima serata, sarà inserita una puntata interamente dedicata alla scuola ed al suo interno Iacona ha avuto l'idea di analizzare l'eccellenza nella scuola italiana attraverso le olimpiadi di matematica. In questo contesto pare possa piacere la storia del Liceo Marconi, una sconosciuta scuola di provincia che in pochi anni sale ai vertici nazionali. La trasmissione andrà in onda nel prossimo settembre in data ancora da determinare.



## The art of CAE technology in manufacture: how to improve and innovate design and manufacture processes

APERIO Tecnología and EnginSoft, in collaboration of LBEIN Tecnalia, the Centre Tecnològic de Vilanova i the Geltrú and the Technical University of Catalunya (UPC), organized two seminars in Barcelona and Bilbao, offering a panoramic view of the most modern CAE technologies available nowadays, and how these help to perfect component design and production processes.

The seminar presented concepts and methodologies that are used to integrate the manufacture process simulation ("digital" or "virtual" prototypes) into the design calculations and in this way improving the design of both. The concept of "co-design" was detailed: this is used by APERIO Tecnología and EnginSoft and takes into account, during the design of a component, the manufacturing process and the resulting characteristics acquired by the material and the component itself. The seminars presented many examples of work done for clients by the companies and collaborators within the group, including examples of casting, forging, pressing, machining, plastic injection, thermal treatment and superficial treatment.

Some clear examples were presented to illustrate these concepts: fatigue calculations that depend on the residual stress and the material microstructure that is obtained from the casting simulation; a "pedal crank" where the force exerted by the cyclist was analysed and several alternatives proposed for the forging and thermal treatment to produce the best mechanical and functional properties; an impact bracket component for a car using the sheet characteristics after pressing/stamping to calculate the impact behaviour. Both seminars were very successful with high attendance and participation (more than 60 people), since the presented examples justified that calculations done throughout the whole design chain generated major benefits for the companies. These also demonstrated the combined use of manufacture process simulation, structural, computational fluid-dynamic, multi-body dynamic (FEM, CFD, MBD) software capable of analyzing and simulating the full development and product manufacturing cycles, even including the ergonomics of the workers in their workplace.

To obtain more information please contact APERIO Tecnología in Spain.

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## El arte de las tecnologías CAE en la fabricación: como se mejoran los procesos de diseño y producción

El arte de las tecnologías CAE en la fabricación: como se mejoran los procesos de diseño y producción APERIO Tecnología y EnginSoft, con la colaboración de LBEIN Tecnalia, el Centre Tecnològic de Vilanova i la Geltrú y la UPC, organizaron dos seminarios en Barcelona y Bilbao, para ofrecer la panorámica de las más modernas tecnologías CAE disponibles hoy en día, y de cómo las mismas permiten perfeccionar el diseño y los procesos de producción.

El enfoque de los seminarios era el de presentar los conceptos y metodologías que se utilizan para integrar las simulaciones ("prototipos digitales" o "prototipos virtuales") de los procesos de fabricación con los cálculos de diseño y así mejorar el conjunto de los dos. Se presentó el concepto de "co-design" que utiliza APERIO Tecnología y EnginSoft que toman en cuenta, durante el diseño de un componente, en su proceso de fabricación y en las características que la pieza y el material adquieren. Los seminarios presentaron ejemplos de trabajos hechos por las empresas del grupo y colaboradores para sus clientes, incluyendo ejemplos de fundición, forja, estampación, mecanizado, inyección de plástico, tratamiento térmico y tratamiento superficial.

Unos ejemplos claros, entre otros, que se presentaron fueron componentes donde el cálculo de la fatiga depende mucho del cálculo de las tensiones residuales y la micro-estructura del material que se obtiene en la simulación de su fundición, un "pedal crank" donde se analizan los esfuerzos del ciclista en la bici, todo su proceso y varias alternativas de forja, un tratamiento térmico y su propiedades mecánicas y de funcionamiento, un componente de choque dentro de un coche utilizando las características de la chapa después de su estampación para calcular su comportamiento de impacto.

Ambos seminarios tuvieron un gran éxito de asistencia y participación, ya que los ejemplos justificaron los estudios y cálculos hechos durante todo la cadena de diseño sacando su beneficio con el uso de varios software de procesos, estructurales, fluido-dinámicos, dinámicos, FEM, CFD, MBD, etc. pasando por analizar y simular ciclos de desarrollo y fabricación del producto, hasta incluir la ergonomía de los trabajadores.

Para obtener más información pueden contactar con APERIO Tecnología.



# Great Lab, research centre for eco-compatible aeronautical engines

The partnership agreement signed on April 2008 by Avio and the Politecnico di Torino has brought to the establishment of Great Lab, an integrated University-Enterprise innovation centre, located inside the campus of the Politecnico di Torino. Great Lab is an integrated multi-disciplinary laboratory, which hosts a research group of 7 researcher and 14 research assistants of the Politecnico di Torino and consists of seven technological areas inspired by the European framework JTI (Joint Technology Initiatives). Great Lab will lead to a significant improvement in the development of technologies for new-generation civil aircraft engines, allowing Avio to produce engine subsystems and components characterized by high performances, low acoustic pollution and low emissions, while keeping low the costs for the maximum customers profit.

The aim of Great Lab is the coordination of shared research activities, the identification of attractive topics for the development of the Piedmont aerospace district, the monitoring of the international scientific scenario for the detection of innovative ideas, the creation of a sector with integrated skills and human resources, also in order to rationalize the use of the available assets. This partnership

creates an intercultural working environment for the staff of Avio and Politecnico di Torino, through areas of basic science, applied research, staff formation and technology transfer, which allows the Politecnico di Torino to benefit from a privileged access to the knowledge base and information network of Avio. Great Lab is part of the project GREAT2020 (Green Engine for Air Traffic), lead by Avio and involving 5 different departments of the Politecnico di Torino (Ingegneria Aerospaziale, Meccanica, Scienze dei Materiali e Ingegneria Chimica, Energetica, Produzione di sistemi ed Economia Aziendale) together with 24 high tech SMEs located in Piedmont, whose aim is the participation of the Piedmont aerospace district to future research projects focused on ambitious eco-compatible aeronautical engines. The partnership among Avio, the Politecnico di Torino and Great Lab endeavors to implement in Piedmont in the next 10 years the vision of the aeronautical industry with reference to the engine technologies, as settled by ACARE (Advisory Council for Aeronautics Research in Europe).

## Sponsor



# Great Lab, per la ricerca di motori aeronautici ecocompatibili

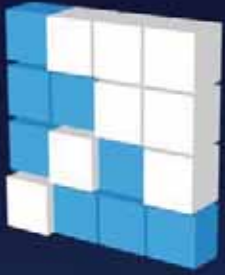


Green Engine for Air Transport

L'accordo di partenariato firmato nell'Aprile 2008 tra Avio ed il Politecnico di Torino ha portato alla costituzione del Great Lab, un centro integrato Università-Impresa per l'innovazione, situato all'interno del campus del Politecnico di Torino. Great Lab è un laboratorio integrato multidisciplinare che ospita un gruppo di ricerca composto da 7 ricercatori e 14 assistenti ricercatori del Politecnico di Torino e si articola in sette aree tecnologiche ispirate dalla piattaforma Europea JTI (Joint Technology Initiative). Great Lab porterà un significativo avanzamento nello sviluppo di tecnologie per motori aerei civili di nuova generazione, permettendo ad Avio la produzione, a costi contenuti a beneficio dei clienti, di sotto sistemi e componenti di motori con alte prestazioni, basso inquinamento acustico e basse emissioni. Lo scopo del Great Lab è di coordinare attività di ricerca condivise, individuare tematiche di interesse per la crescita del distretto aerospaziale piemontese, monitorare il panorama scientifico internazionale per l'individuazione di idee innovative, creare un settore di competenze integrate e risorse umane, anche al fine

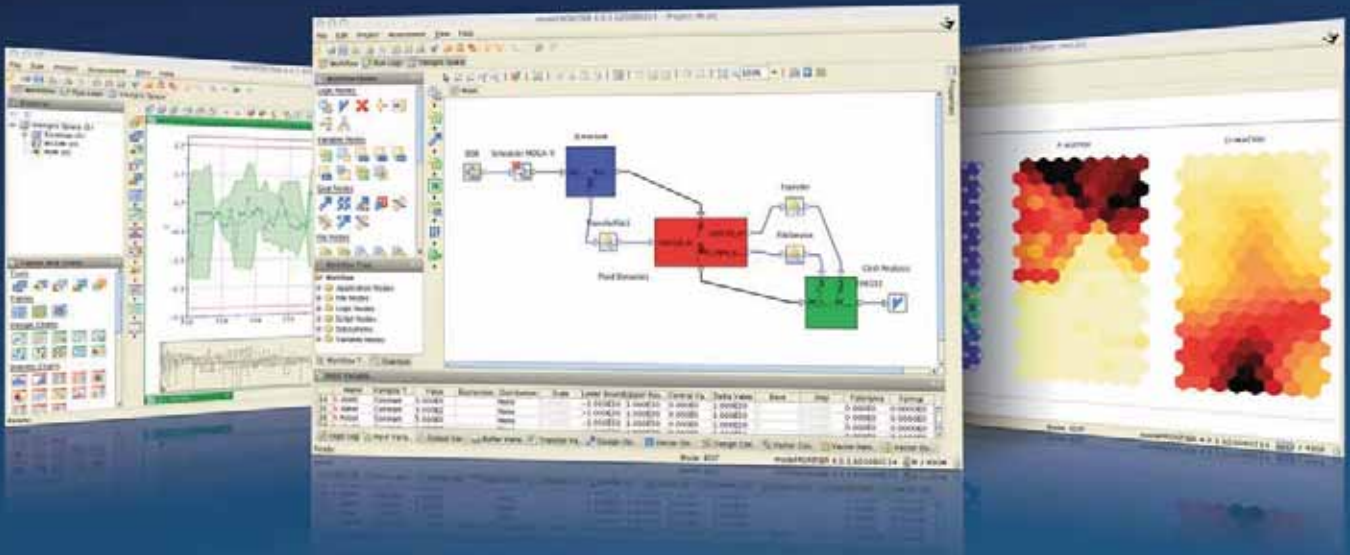
di razionalizzare le risorse in comune. Tale partenariato crea un ambiente di lavoro interculturale per lo staff Avio e Politecnico di Torino attraverso aree di scienze base, ricerca applicata, formazione dello staff, e tecnologia transfer, in cui il Politecnico di Torino può godere di un accesso privilegiato alla base di capacità e al network di informazioni di Avio. Great Lab è parte del progetto GREAT2020 (Green Engine for Air Traffic), condotto da Avio e che coinvolge 5 diversi dipartimenti del Politecnico di Torino (Ingegneria Aerospaziale, Meccanica, Scienze dei Materiali e Ingegneria Chimica, Energetica, Produzione di sistemi ed Economia Aziendale) insieme ad altre 24 PMI altamente tecnologiche presenti in Piemonte, con lo scopo di permettere la partecipazione del distretto aerospaziale Piemontese ai futuri progetti di ricerca su ambiziosi motori aeronautici eco-compatibili. La partnership tra Avio, il Politecnico di Torino ed il Great Lab ha lo scopo di implementare in Piemonte la visione dell'industria aeronautica nei prossimi 10 anni riguardo alle tecnologie per motori, come stabilito da parte dell'ACARE (Advisory Council for Aeronautics Research in Europe).



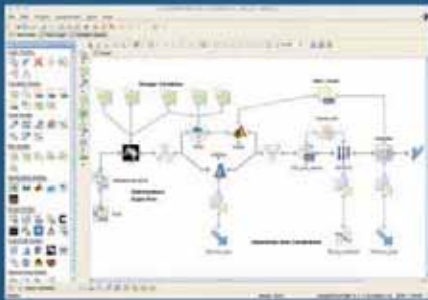


# modeFRONTIER®

the multi-objective optimization and design environment

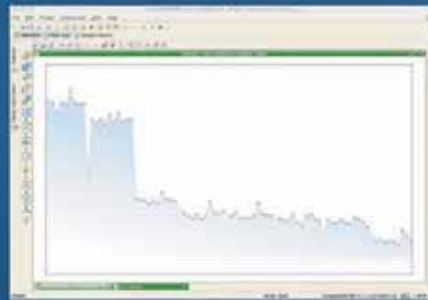


**modeFRONTIER®** is a multi-objective optimization and design environment written to allow easy coupling to almost any computer aided engineering (CAE) tool.



## Process Automation

The user-friendly GUI allows all the software tools in use to be linked together, to create an integrated CAE environment.



## Optimization Algorithms

Whether the problem is single or multi-objective, modeFRONTIER® offers a wide variety of state-of-the-art algorithms, ranging from Simplex and Derivative Methods to Genetic Algorithms, Particle Swarm and Game Theory.



## Post Processing

The user can take advantage of the advanced post-processing toolkit to create multi-dimensional plots and perform sophisticated statistical analyses, giving more insight into results. The automatic report generator is ideal for project documentation.

